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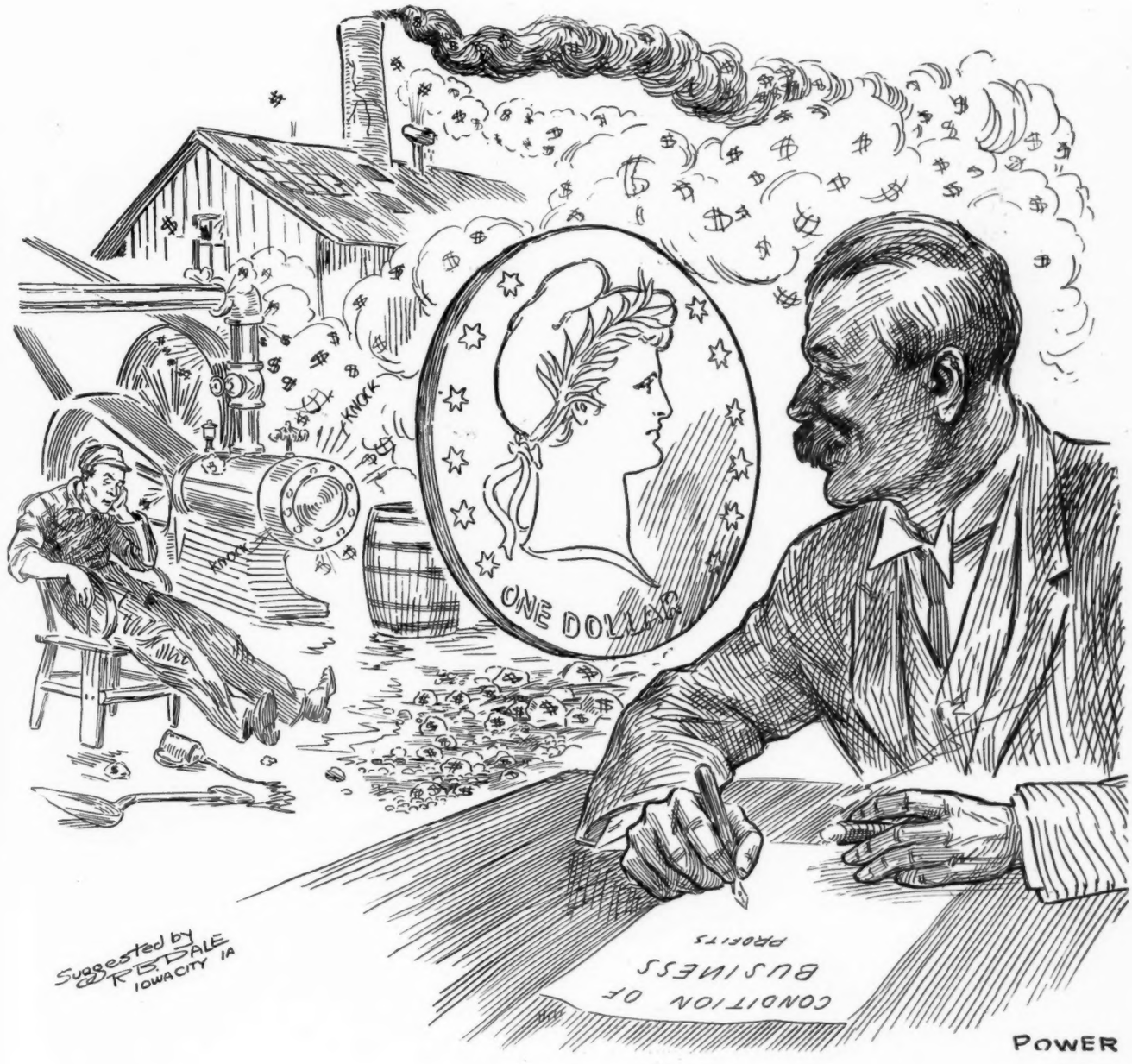


THE DOLLAR HE IS MAKING BLINDS HIM TO THE DOLLARS HE IS LOSING

Cleveland Municipal Electric Plants

By A. D. Williams

SYNOPSIS—The city of Cleveland now owns and operates two small municipal plants but is building one of 22,500 kw. capacity. Progress on this was retarded, however, because of legal entanglements over the bond issue. The city has adopted a rate schedule giving a maximum of 3c. and a minimum of 1c. per kw.-hr.

There is now under construction in Cleveland, Ohio, a 22,500-kw. municipal lighting plant, which, when completed will be the largest municipal plant in this country. In addition there are now two small lighting plants operated by the city which came under its control when the towns that built them were annexed to Cleveland in 1910. The older of these plants is located in Collinwood. It was built in 1901 and operated in connection with the water department of that town. The second plant, known as the Brooklyn plant, is more modern, having been built in 1906 to replace an older plant built about the same time as the Collinwood plant.

Another municipal activity in Cleveland was the three-cent traction company organized by former mayor Tom L. Johnson which built and operated a number of lines and which, after considerable quarreling, was merged with the Cleveland Railway Co., by the Taylor grant, which extended the franchise of the railway company and gave a universal rate of fare of 3c. with a charge of 1c. for a transfer which, at present, is refunded by the conductor who takes up the transfer.

About three years ago a vigorous campaign was initiated to have a municipal lighting plant large enough to supply a part of the business district and to enable the city to do its own street lighting. One of the arguments in favor of the new plant was the price the city was paying for street lights as compared with those charged in other cities. The Cleveland Electric Illuminating Co. was charged with working in opposition to the proposed bond issue, one of the local papers was rabidly in favor of the bond issue, two were opposed to it and a fourth was unprejudiced. The illuminating company reduced its prices for street lights and this was hailed in some quarters as one of the favorable results of being ready to fight them on their own ground. The campaign was rather bitter on both sides and after election it was found that the proposal to bond the city for $2,000,000 to be used for the construction of a municipal lighting plant had been carried.

As soon as the new city administration under Mayor Newton D. Baker came into office steps were taken to start work on the new plant. F. W. Ballard was appointed construction engineer and A. B. DuPont consulting engineer, and an issue of $500,000 in bonds was authorized for starting construction. At this point a taxpayer's suit was started, praying for an injunction restraining the issue of the bonds and attacking the legality of the bond issue upon technical grounds, alleging that all the requirements of the state laws had not been fulfilled. The city sinking-fund commission was persuaded to invest its funds in this issue with the expectation of reselling the bonds when the legal entanglements had been cleared away.

The rates of the Cleveland Electric Illuminating Co. are based on a sliding scale, each connection being rated

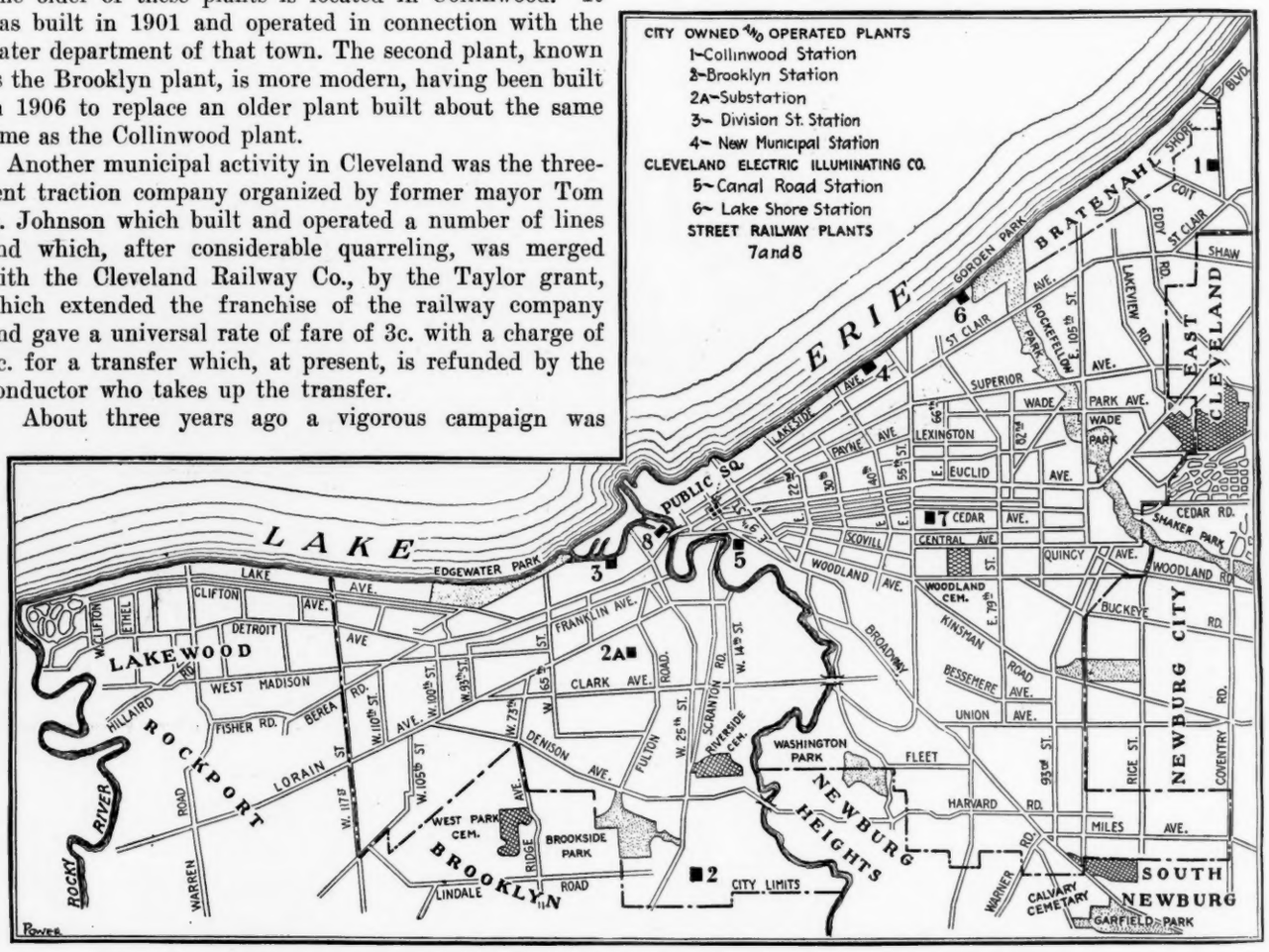


Fig. 1. Map of Cleveland, Showing Location of Electric Generating Plants

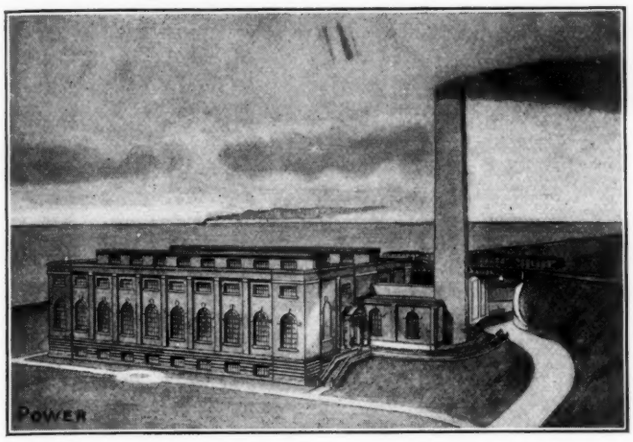


FIG. 2. NEW MUNICIPAL PLANT, FROM ARCHITECT'S DRAWING

at a certain minimum consumption, and all consumption above that minimum being charged at a lower rate. Residence and store connections have a maximum rate of 10c. per kw.-hr. and a minimum rate of 5c. per kw.-hr., the average price being about 6c. Power connections are rated in a similar manner, the prices for successive quantities decreasing to a minimum in the neighborhood of 2c. per kw.-hr. These rates are lower and more favorable both to residence and large quantity consumers than those charged in most large cities. The municipal plants have been selling current at rates slightly lower than the illuminating company and one of the issues which assisted in carrying the bond issue for the new plant was that of a maximum rate of 3c. per unit and a lower rate with a sliding scale for large consumers. In March, 1913, at a time when the lighting department expected to have the new plant in operation in the fall, a rate chart was published, Fig. 9, according to which the rate per unit varied from 3c. to 1c. and at this time several contracts were made with manufacturing concerns for a term of five years on this basis. These rates went into effect immediately for those customers taking an average service of at least 50 kw.

To illustrate the use of the chart, assume the customer has a 200-kw. service connection and he uses 20,000 kw.-hr. in any one month, his rate will be based upon

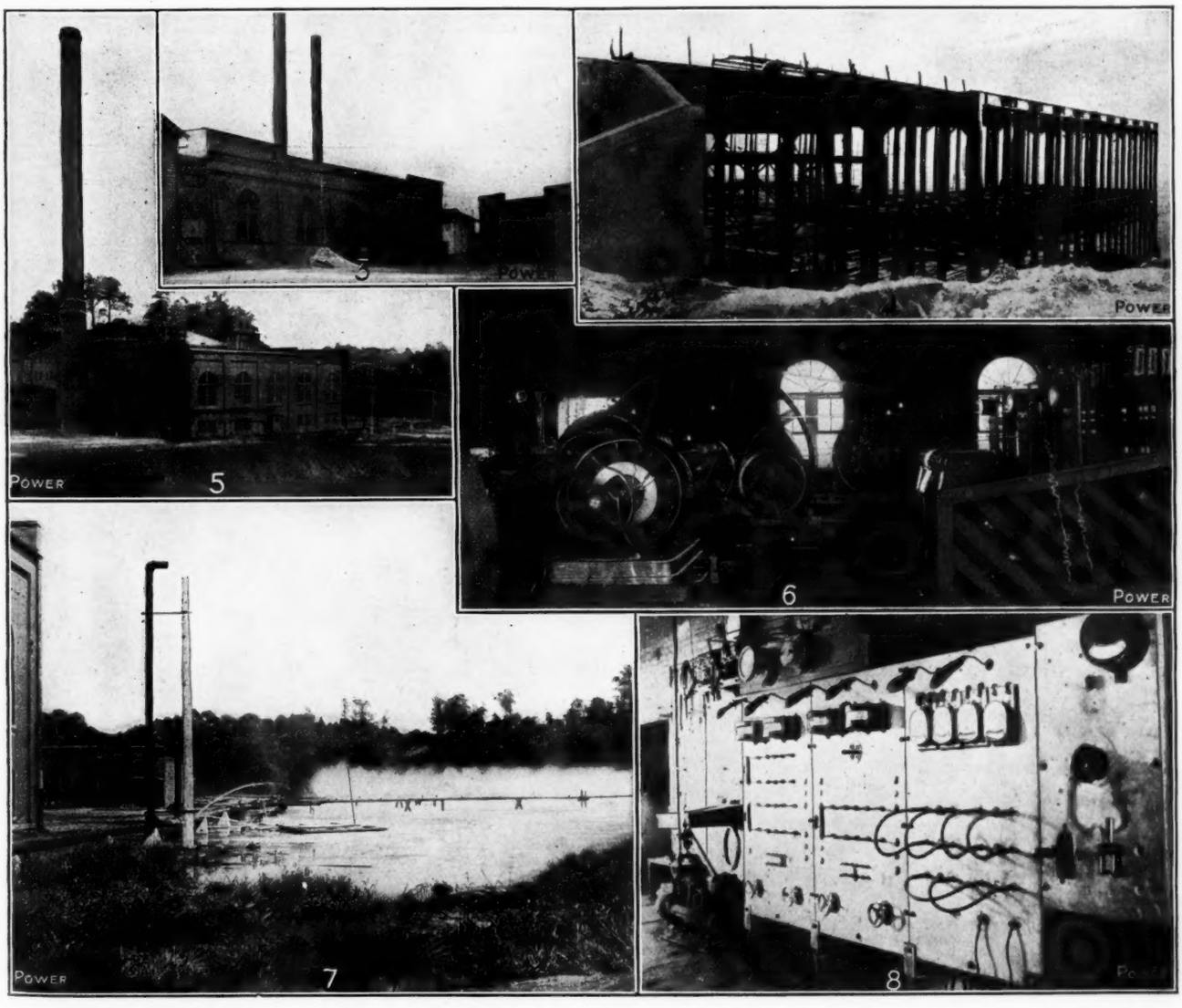


FIG. 3. COLLINWOOD PLANT. FIG. 4. STEELWORK OF NEW PLANT. FIG. 5. BROOKLYN PLANT. FIG. 6. GENERATORS IN COLLINWOOD PLANT. FIG. 7. SPRAY POND AT BROOKLYN PLANT. FIG. 8. SWITCHBOARD IN COLLINWOOD PLANT.

an average use of his full connected capacity for 100 hr. and his rate will therefore be for that month 1.6c. If, however, he uses 50,000 kw.-hr. in one month his rate will be based upon an average use of his full connected capacity for 250 hr. and his rate will accordingly be 1c. This is found on the chart by taking the intersection of the horizontal line from the 200-kw. service connection with the vertical line representing the average hours used and from this intersection following the diagonal line upward to the right-hand side of the chart. Where this diagonal crosses the edge of the chart will be found the figures which represent the rate to be paid. If the number representing the average hours used is found at the bottom of

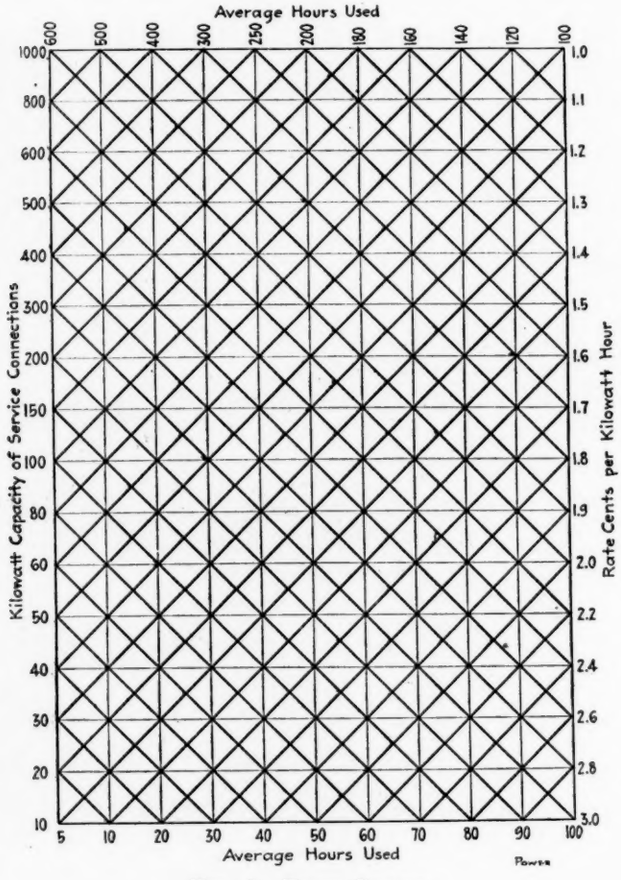


FIG. 9. RATE CHART

the chart, then the diagonal must be followed downward instead of upward to find the rate.

The chart as shown represents the rate schedule for a five-year contract. For a one-year contract use the chart in the same way, except that 10 per cent. must be added to the rates.

A minimum guarantee will be required in all contracts of 75c. per month for each kilowatt capacity of the service connection, but this is not to be added to the bill, it is only a guarantee that the monthly consumption shall equal this amount, and no bill for light or power will be less than 75c. per month.

One of the problems before the lighting department has been the limited capacity of the Collinwood plant and that at Brooklyn, both of these plants serving outlying districts. The Collinwood plant is loaded to its full capacity and the machinery is antiquated and not in first-class condition. The capacity of this plant is about 550 kw. The Brooklyn plant contains one 500- and one 1000-kw. Westinghouse-Parson turbines and serves a growing neighborhood so that an increase in capacity would soon become necessary.

A short time after the partial bond issue became available it was decided to install a 1500-kw. turbine unit in the Division St. pumping station of the Water Department, where there was surplus boiler capacity sufficient to operate it. This makes the present total municipal plant generating capacity 3550 kw.; the new plant, now under construction will add 22,500 kw.

As to when the new plant will be finished and in operation, is questionable. A second bond issue of $500,000 was authorized a few months ago by the council, but, owing to the unsettled question as to the legality of the entire issue, the bond dealers refused to bid for it and through an employee of one of the local bond dealers a taxpayer's suit was again started and the sale of the issue enjoined temporarily. The Ohio Court of Appeals has just rendered a decision, however, upholding the validity of the bond issue and placed the cost of the suit on the plaintiff. The steel frame for the new plant is practically completed and ready for the construction of the walls and roof, as may be seen by reference to the view given in Fig. 4.

One of the very interesting questions to be settled when the new plant begins operation will be the practicability of the rates at which it has been decided to sell energy. These rates, as given in the chart, Fig. 9, now apply to consumers with an average demand of 50 kw., but will be extended to cover all other connections upon the completion of the new plant. These rates will be considerably below those offered by the illuminating company, which has an extremely modern and economical generating plant with a capacity of about 90,000 kw., which was described in POWER, Mar. 18, 1913.

Pump-Valve Leakage

It has long been maintained that a steam pump is the most abused and neglected piece of equipment about a steam plant. But ninety-nine engineers in every hundred are perfectly satisfied that their pumps are all right, and so long as the pump runs and performs the required service they are content with things as they exist.

This condition may prevail in small plants, perhaps, to a greater extent than in the large installations, but if a pump is allowed to operate month after month, and year after year, without overhauling, it is pretty evident that it is not in as good condition as it might be.

Pump ailments have been set down as short stroking, leaky piston-rod packing, leaky steam valves and piston, air leaks in the suction pipe and other minor troubles.

The accepted standard of piston speed for a boiler-feed pump is not more than 100 ft. per min., however, a lesser piston speed is advisable. If the piston packing leaks so that the water surges from one end of the cylinder to the other, the piston speed of the pump must be increased to get the desired volume of water. If the piston packing is tight and no leakage occurs past the piston, but the water valves and valve seats are worn (and all valve seats do wear), there will be excessive leakage of water past the valves, which reduces the capacity of

the pump over what it should be when running at the same speed and in good condition.

For instance, if a pump has a 6-in. water cylinder and a 10-in. stroke it will pump a maximum of 257 gal. of water per min., at a speed of 54 r.p.m. Suppose that the suction- and discharge-valve seats of the water end of the pump are worn, and most of them are, after being used a while. The water from the source of supply enters the pump cylinder, after passing up through the suction or intake valves. The top of the intake valves are subject to the discharge pressure in the pump, which lifts the discharge valves from their seats.

While one end *A* of the pump cylinder is discharging, the valve *B* is closed and the valve *C* is open. On the other end of the cylinder the position of the valves is reversed, and the valve *D* is open, admitting water to the end *F* of the cylinder, but the valve *E* is closed.

If the valves and seats are worn, water discharging from the end *A* of the cylinder will pass up through the discharge valve *C*, but some of the discharge water will be forced between the suction valve *B* and its seat into the intake passage and then down into the suction pipe, or up through the valve *D*, and into the end *F* of the cylinder. What water goes toward the suction pipe counteracts the upward movement of the water, due to the partial vacuum formed in the end *F*, of the pump cylinder. The amount of water entering the end *F*, from the end *A*, reduces the capacity of the pump just that much.

On the same stroke, water, under pressure, is being forced back between the valve *E*, and its seat, into the end *F* of the cylinder, which further reduces the capacity of the pump.

This is a condition present in most pumps to a greater or less degree, generally greater, because the engineers do not give the valve seats proper attention. There is no gain shown by skimping on the coal pile, working over time packing leaky pipe flanges and valve stems, etc., if the steam pumps are allowed to run in such a condition that they are consuming a great deal more steam than they should.

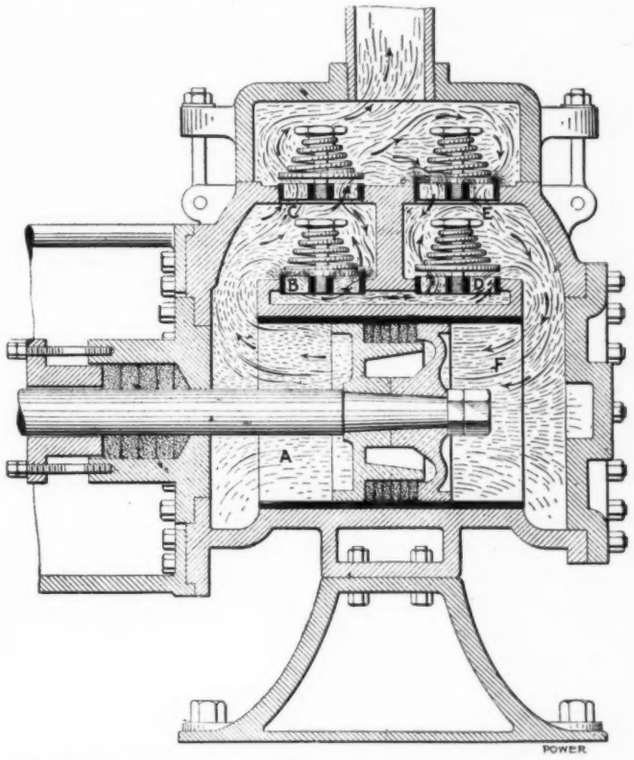
For instance, in one plant there were two compound, simplex pumps, operating at 25 r.p.m. One used 1000 lb. of steam per hr., the other pump nearly double the quantity, or 1800 lb., in doing the same work. The trouble was that the valves and valve seats on the wasteful pump were worn out of true.

One would suppose that the engineer of that plant would have suspected something was wrong with the wasteful pump, but not so. He was much like the engineer of another large plant. This man was a progressive, intelligent, uptodate engineer, who claimed he had never had any trouble with his pumps.

Something like a year ago a new heating system was put in and guaranteed to make a large saving in fuel, but the system did not come up to expectation. An investigation showed that the circulating pump was wasting a large amount of steam. The water-valve seats of the pump were refaced and the service was so improved that in half an hour after the pump was started the necessary amount of water had been supplied and the pump was stopped. The pump was working against 500 lb. pressure.

It is the procedure in several shops where pumps are manufactured to force the valve seats into place in new pumps. This may cause portions of the seat to bulge, making as many high spots on the valve face as there are bars. If bulging occurs it is just as necessary to reface the valve seats as if they were badly worn, which can easily be accomplished by a pump-valve reseating machine, made for the purpose, and which can be used without dismantling the pump.

Another instance can be cited where worn pump valves necessitated running two pumps, when one in proper condition could have supplied all of the water required. These pumps were each supplied with steam through a ¾-in. steam pipe. They were run about 75 strokes per minute to supply the required water. The manager finally decided to have the pump-valve seats faced true. After



DIRECTION OF WATER FLOW THROUGH PUMP WITH LEAKING VALVES

one hour's work one pump was running at 18 strokes per minute, supplying all the water necessary, the other pump being idle.

In another instance a pump had been in use for 11 years. It had been condemned and a new one was to take its place. However, before it was discarded, the valve seats were machined and the pump put in serviceable condition, good for another 11 years' work, and, furthermore, saving in the neighborhood of $350 in the cost of a new pump.

As a last instance of many which could be cited, a pump, fed by a 1½-in. steam line, was run at a speed capable of supplying 615 boiler horsepower with feed water. After putting the valve seats in proper shape the speed of the pump was cut down about 65 per cent. of its former speed and is doing good work today.

Most engineers are willing to believe the worst that can be said about a neighboring plant, but cannot, or will not, see the shortcomings of their own. They can tell you all about the engine, its steam consumption and other data about the plant, but on the subject of the

steam pump, while admitting that they are steam eaters, they are silent. They do not know the actual condition of their pumps, for one thing, and because the pumps have been in use for years and have been able to keep the boilers supplied with feed water, it is assumed that the internal parts are in good shape and further consideration of their economical operation is neglected. The pumps, therefore, are run at a faster speed than they should, to supply the necessary water, and the owner pays the excess fuel bill because of excessive steam consumption.

Shop Demonstration of Water Flow in National Heater

In order to set at rest any misconceptions regarding the actual flow of water in a National direct-contact heater, a demonstration was made in the shops of the makers, The National Pipe Bending Co., New Haven, Conn. As the flow of water could be seen only by making one side of the heater of glass, one side of the heater was removed and a glass plate substituted, sufficiently large to come well above the water line, thus inclosing the lower part of the heater in which the water is retained. Water was allowed to flow through the heater at the rate of 850 hp. capacity per hr., the heater having a capacity of 1000 hp. A description of this type of heater was published on page 714, May 14 of last year.

The Use of Economizers*

The speaker first described with the aid of illustrations the dependence of chimney costs upon their height and upper inside diameter, the relations between the chimney height, the hourly consumption of fuel and the operating costs and the temperature of the gases entering the chimney.

Of great importance in determining the gross dimensions of the economizer, are the temperature of the entering water and the drop in temperature of the flue gases that are employed.

The entire installation will be cheapest when the utilization of the flue gases in the economizer goes the farthest. How far the flue-gas temperature is then economically utilized depends upon the temperature of the feed water. Assuming a uniform load, the most economical plant for low feed-water temperatures corresponds to a chimney temperature of 266 to 284 deg. F.; for average feed-water temperatures, 338 deg., and for high feed-water temperatures, 392 deg. If the service is variable it is proper to proportion the outfit for the average efficiency.

The question whether in large plants one common economizer or separate equipments behind each boiler should be used cannot be settled by general principles since it depends upon working conditions. With very regular load a common economizer would be advantageous because of its cheaper first cost and its smaller radiating surface, while where boilers are frequently cut off, as in electrical stations, individual economizers are preferable, there being danger that otherwise a too great cooling down of the flue gases may reduce the draft and also that the tubes will be fouled.

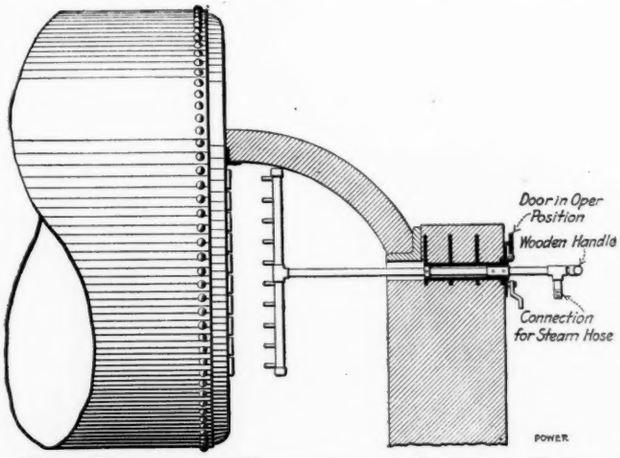
Summing up, the question of employing economizers may be answered by saying that they are primarily of use in enabling the designer to lay down an economical plant, by most completely utilizing the flue gases and obtaining the best combustion. Their field of usefulness will widen the more that small boiler plants disappear and hand stoking gives place to mechanical. The size of an economizer as compared with the boiler-heating surface—which cannot be settled by a fixed ratio, since it depends upon the feed-water temperature—should increase with the pressure and with increased attempt to employ in the boiler itself only heating surfaces of high value.

*Abstract of a report by Engineer Gleichmann, presented at the Munich convention of the International Association of Steam Boiler Inspection Societies. Translated from "Glückauf."

Myers Improved Boiler-Tube Blower

A new tube blower for horizontal, return-tubular boilers has been developed, and has successfully weathered two years of strenuous testing. It is impossible for the tube blower to burn out or deteriorate in the hot gases, because when not in use it is withdrawn bodily from the boiler setting.

The design is such that each individual boiler tube received a single powerful jet of steam at its exact center. There is, therefore, no turning of the steam through an



TUBE BLOWER IN POSITION FOR BLOWING TUBES

angle or the dissipating of its force by passing it through the 2 ft. of hot gases in the rear combustion chamber. Therefore, a powerful cleaning effect is produced on the inside surface of the tubes with a minimum amount of steam. As the blower is removable, one blower can serve any number of boilers, provided they have the same tube spacing, each boiler being provided with the cast-iron slot door for the insertion and withdrawal of the blower.

The blower part consists essentially of a tee, formed of standard steam pipe with nipples on the cross piece, which act as steam jets. These jets are specially designed and interchangeable with other jets with different-size nozzles, making them adaptable to any set of local conditions that may be found, as to steam pressure and size of boiler tubes.

The blower portion is fitted with a wooden handle and a hose connection to which the hose, preferably a flexible brass one, is attached. The steam connection for the blower should be made near the center of a pair or battery of boilers at their rear; thus the blower can be taken

in either direction without disconnecting to clean the tubes of either boiler.

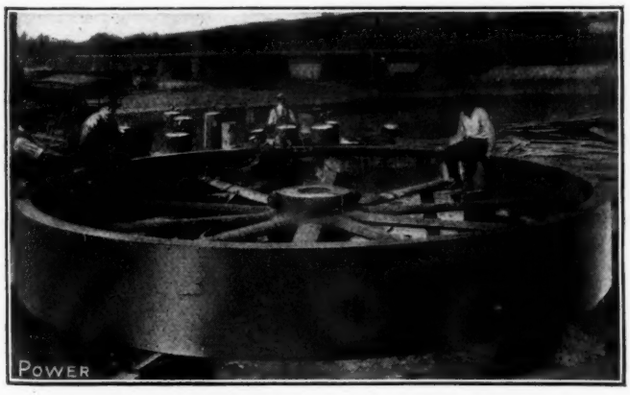
The other part of this device consists of a cast-iron slotted door, set horizontally in the rear wall of the boiler setting, exactly opposite the middle row of tubes, as shown in the illustration, where the blower is inserted through the slotted door in its operating position ready for cleaning the tubes.

The operation of cleaning a boiler consists of opening the door covering the slot in the rear of the boiler and inserting the blower. Then the blower head is turned through an angle of 90 deg. and the guide block is slipped up into position in the slot in which it has a sliding fit. This guide block holds the blower head containing the nozzles in alignment with any vertical row of tubes in the boiler. The blower is then slid along this slot opposite the left-hand row of tubes, then to the right to the next row, and so on until each vertical row of tubes has been thoroughly cleaned, the jets of the blower acting in perfect axial alignment with the individual tubes. After cleaning the tubes the blower is again removed by turning 90 deg., and is then pulled out of the slot. It was invented and patented by David Moffat Myers, 17 Battery Place, New York City.

Autogenously Welded Flywheel

A flywheel which has been welded in four places is shown in the illustration. The work was done at the No. 2 mill of the American Thread Co., at Holyoke, Mass., by THE Welding Co.

While the engine was being moved from one of the mills the flywheel was dropped, breaking one spoke out entirely and cracking two others. It was found that a new wheel would cost $4800, and there would be a considerable delay which would add very largely to this cost.



Welding Broken Flywheel

The welding was undertaken under a guarantee of no charge if not successful.

The repair was completed in one day. The welding was performed without turning the wheel over, it being, however, welded from both sides. It was a somewhat remarkable performance to weld these spokes from the underside as this is an exceedingly difficult operation on gray iron.

When the wheel was put into operation again it was found to be true within a reasonable degree being not more out of round than such large wheels are apt to be in ordinary operation.

The welds were tested by jarring the spokes before putting the wheel in commission, and the engine was then run at an excess speed without the belt to test the welds.

Pumping Plants of the Western Water Co.

Prompted by the urgent need of the oil fields, C. B. Colby, Bakersfield, Calif., recently organized a corporation to supply water for boilers, oil-well drilling and domestic purposes, to the California Midway oil field, the largest in the world.

This field was at that time being supplied with boiler and drilling water from deep wells which contained so much sulphur and salt that it could not be used for domestic purposes, and domestic water was transported in tank cars 48 miles and sold in the fields for 20c. a bbl.

Because of these conditions several unsuccessful attempts were made to supply the field with additional water, one notable among them being a plan to bring water down from the mountains on the south, a distance of about 40 miles through a pipe line. This was abandoned on account of its engineering difficulties, which made the cost almost prohibitive.

The problem was solved by drilling a well near where the Kern River turns to run into a lake, about 12 miles from the oil fields. It was pumped continuously for six days to establish, without a doubt, the quantity and quality of the water which was found suitable for both domestic and boiler purposes.

A corporation known as the Western Water Co. was organized and plans were made to install pumping machinery of sufficient size to pump 2,000,000 gal. per day to a storage tank on the highest hill in the field and distribute the water by gravitation.

The pipe line is made with couplings, consisting of a body ring and two ring flanges, through which bolts are fitted, and when drawn up compress a ring of packing against the outside surface of the pipe, thus making a water-tight joint. The use of this type of coupling facilitates repairs in case of leakage or damage to a pipe line, due to washouts, caused by heavy rains in the hills.

One of the pumping plants consists of two No. 7 Layne & Bowler vertical turbine pumps; the capacity of each is about 2,000,000 gal. per day. These two pumps are driven by one 50-hp., single-cylinder, horizontal-type engine for the pump in well No. 5 and one 80-hp., three-cylinder, vertical, heavy-duty gas engine, for the pump in well No. 7.

The elevation at the surface of the ground where these pumps are installed is 297 ft. above sea level. When not being pumped, the water in the wells rises and runs over the top of the casing. When being pumped to the full capacity of the pumps, the water is lowered only about 58 ft.

The water from these pumps is discharged into two 10-in. pipes which connect to Y-branches on the 14-in. discharge line leading to a concrete reservoir 672 ft. distant.

The reservoir is 40x100 ft. by 5½ ft. deep, divided into two basins 40x50 ft., so that one side can be emptied and cleaned, without interrupting the water supply.

The water first enters a small box or settling basin be-

fore flowing into the reservoir, which prevents sand and silt from entering the 20-in. suction pipe leading to the 9x18-in. power pumps in the main building. The elevation of the floor of this building is 310 ft. 6 in. Water is thus supplied to the pumps, under slight pressure.

The equipment in the main building consists of three 9x8-in. pot-valve power pumps, direct connected to three 250-hp. four-cylinder engines, operating on natural gas.

The pumps are fitted with 10-in. discharge pipes which connect to the Y-branch fittings in the 12-in. main line.

Each pump is fitted with a relief valve set at 550 lb. pressure. The line pressure when a plant is in operation being from 500 to 525 lb. per sq.in., 300 lb. of which is static and 200 to 225 lb. is caused by friction in the pipe. There are also four alleviations on the main line at this point to take care of any water-hammer that may occur.

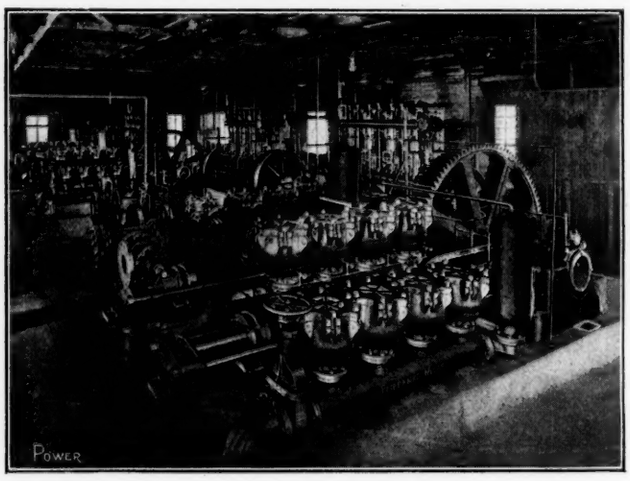
All Y-branches, gates and other fittings were placed in the pipe line and tested to 1000 lb. per sq.in. hydraulic pressure.

The main building, 50x95 ft., is a substantial frame structure, covered with corrugated iron. The roof trusses are built to carry a load of two tons on the traveling crane, which is fastened to them. The crane was provided for the handling of heavy pump and engine castings, if necessary. The floors are concrete.

The average consumption of gas per month is 5,500,000 cu.ft. Lubricating oil consumed averages 200 gal. per month. The oil is pumped from the crank case of the engines to filters, and from there gravitated to the tanks that supply the oiling system.

For auxiliary equipment there is an electric-lighting plant to light all of the buildings, the engine of the light equipment also drives an air compressor which charges three receiving tanks.

The compressed air is used for starting the large engines and by its use any one of the 250-hp. engines can be easily started by a single operator.



THREE 250-HP. GAS ENGINES DIRECTLY CONNECTED TO THREE 9x18-IN. POWER PUMPS

There is also a refrigerating plant of one ton capacity, a machine shop containing a lathe, drill press and pipe-threading machine, etc.; a blacksmith shop and a garage, also an oil house, where all waste oil is collected and filtered, and a heavy press for squeezing the oil out of wiping rags.

Station No. 2 receives the water coming through the 12-in. line from station No. 1 in a 5000-bbl. tank near the power house.

The machinery in station No. 2 consists of three 100-hp. horizontal-tubular boilers and three temporary 40-hp. firebox boilers, one 18x6x18-in. Coalinga pattern pump, and two 18x18½x18-in. duplex pot-valve pumps. The fuel used at this plant is natural gas and amounts to about 6,000,000 cu.ft. per month. This station is also equipped with a 6½x8-in. triplex power pump driven by a 50-hp. induction motor.

Water is discharged from the large line pumps in this station into a 12-in. manifold to which is connected the 8-in. line, which discharges the water into the 55,000-bbl. storage tank, a distance of two miles.

A feature in connection with the operation of the system is that no trouble has been experienced with either machinery or pipe line. The 250-hp. gas engines at station No. 1 have operated continuously on an average of twenty-six 24-hr. days a month for 20 months, and the 50-hp. single-cylinder engine pulled a load amounting to 60 hp. for a period of 10 months. The gas engines and pumps other than those mentioned were built by the Fairbanks-Morse Co.

The Western Water Co. supplies water to approximately 60 per cent. of the Midway-Sunset oil fields, or a total of 30,720 acres of oil land. The water is sold at 3c. a bbl., whereas heretofore operators have paid from 6c. to 20c. per bbl. At the present time 35,000 bbl. of 42 gal. each are being delivered daily.

Bill B. Banger on Boiler Explosions

BY BILL B. BANGER

When a feller's got things on his mind th' best thing t' do is t' get um outer th' way as soon as possible and that's what I'm goin' t' do. Some fellers can sleep over a live volcano and don't seem t' know it's there. When I speak of volcanoes I mean some of these dinged lap-joint steam bilers what has been in service a quarter of a century, more or less, and th' worst part of it is that innocent people, what don't know th' difference between a biler and a sausage are riskin' their lives and legs every day in th' year, except perhaps Sundays, and are so glad they have a job they think they are favored by Providence, and By Heck they are, for if it wasn't for th' care of some sich thing most of um would have attended their own funeral long ago.

When the engineerin' papers can spout about so many biler bustups and show pictures of um t' boot, a tellin' how th' thing happened and sometimes wonderin' why it didn't bust before, it makes a feller want t' ease up on th' steam pressure and wonder how many cracks there are under th' lap joint of th' biler he is nursin'.

When a biler goes t' smash there's usually a good reason for it and th' first thing a feller wants t' know is what was th' cause, and why did there domn thing do so much damage. From th' little experience I have had with biler explosions, th' cause is easy t' find, provided th' company ownin' th' biler will let a feller in t' examine th' remains. It's easy enough t' trace an old crack, or t' detect signs of a burnt biler, and th' state of th' sheets and tubes gives a pretty good idea as t' how th' biler has been taken care of.

Generally th' cuss of an engineer gets th' blame fer

an accident t' a biler, and as he can't talk back in most cases, he goes t' his grave, kind of dishonored like, and reckoned for a time among th' town folk as havin' brought on his own destruction; at th' same time his memory is cursed by th' relatives of th' men killed with him and he has t' carry the hatred of those who happened t' be injured in th' racket t' his silent grave.

Th' humble opinion of your Uncle Bill is that somethin' is wrong. Of course, an engineer should be a careful man and he should not allow a biler t' be operated in an unsafe condition, as has been said several hundred times before, but th' engineer ain't th' only nigger in th' coal pile, not by a tadpole. It's easy enough t' blame th' engineer, but what's th' matter with turnin' th' search light on th' owner of th' biler what blew up and see what kind of an excuse he'll spring for operatin' a biler what common sense would tell a half-baked pippin was only fit for old junk and at a cheap price at that?

"As I Looked at th' Wreckage, I Calculated Somethin' Must of Let Go Unexpected Like."

Th' Good Book says somewhere, I think, "come let us reason t'gether," and it won't do us a mite of harm t' do th' same. I'll be willin' t' bet seven cents, if I can find any takers, that there ain't one man in 1000 what would put in an engine, feed pump, or even an oil filter and expect any one of um to last from 20 to 25 years without repairs, but at th' same time most of um would put in a cussed lap-joint biler and kick if th' engineer asked for a new handhole crab, fer th' back end of th' biler, inside of ten years.

'Tain't no uncommon thing t' go int' a biler room and have th' engineer hitch up his pants and throw out his chest and tell you th' biler ain't had a cent's worth of repairs since it was put in service 20 years ago, and that it was a second-hand biler at that time, so nobody knows just how old th' old kettle is. It ain't much to brag about t' my mind and it's a pretty sure thing that if a biler has been heated up and cooled twice a day for 20 or 25 years it is about time somethin' was done with it, if it's nothin' mor'n givin' it a dose of th' hydrostatic test. I kind of calculate that most bilers of uncertain age would bust a gizzard or somethin' of the sort and by th' procedure prolong th' lives of several prospective victims.

I don't know why some insurance and inspection companies don't look int' these matters more closely. Of course, insurin' bilers is more or less of a gamble on th' part of both parties. Th' owner takes th' side that th' biler is likely t' blow up and is willin' t' bet th' insurance company a certain sum that it will. If th' biler holds together th' owner is out th' amount of th' premium. On th' other hand, th' insurance company gambles that th' biler won't bust and bets th' owner th' amount of damage t' property against th' premium that it won't. Th' insurance company wins most times, or it would soon go out of business, but on th' other hand, there is th' temptation t' run a risk on an uncertain biler just a little longer. I won't come out flat footed and say that this is th' case, but things what has come t' my attention of late years lead me t' suspect that it is so.

I was told by a feller, what knows, that one of th' bilers what exploded recently had been carried by one insurance company and they had dropped th' risk like a hot iron; it was refused by another and was then taken up by a third company. Now, if that is so, what protection does biler insurance give mor'n that it insures th' owner against loss of property in case th' dinged biler does explode? It don't protect him against damage suits due t' killed and injured pepole what had nothin' t' do with th' biler. I take it that most biler owners don't take this last proposition int' consideration until it is t' late

Of course, th' biler is inspected shipshape at certain periods, if the inspector gets a chance t' get int' it. But if th' owner won't get it ready fer inspection, I don't see where th' insurance company comes in. T' be sure they can make an external inspection, but that don't give much assurance that th' biler is all right, By Heck, especially when th' way things are managed around th' plant is such as t' make a confidin' poodle dog suspicious.

If th' owner of a biler gets it insured and then refuses t' have repairs made as recommended by th' inspector, or refuse t' let th' inspector get int' th' dinged biler it looks as if all that was wanted was th' protection against damage in case th' biler did go t' smash. Th' safety of th' men seems t' be a secondary consideration in the estimation of some biler owners.

Now yer Uncle Bill believes in biler inspection and insurance when it's carried on with common sense, but there ain't any sense for one company t' insure a biler after another has canceled th' risk because of th' condition it was in or because of th' abuse it was gittin'. It ain't honest business no matter how yer look at it, and there ain't any more sense t' it then t' eat beef steak that's so tough yer can't stick yer fork in th' gravy, when yer can get somethin' tender fer th' askin'.

Safety first, profits next, would be a good motto fer all concerned t' adopt when monkeyin' with steam bilers.

Big Men start by firing up their imagination, and then they throw over the lever of will power, and the machinery moves. Imagination is the fire under the boiler. Will power is the steam in the boiler. Big minds and big machinery are moved much in the same manner. A small man has little imagination; naturally, never gets up much fire. The bigger the imagination, the more the horsepower. The more the will power—the more the results. Dream and work.—"The Silent Partner."

Standard Tubular-Boiler Specifications

The National Association of Tubular Boiler Manufacturers has recently issued a set of specifications covering fire-tube boilers and 34 individuals and companies who are members of the association have approved and adopted it. The principal features are as follows:

MATERIALS

The shell, heads and covering strips of the standard boiler shall be of flange steel as described in the standard specifications of the Association of American Steel Manufacturers. All such plates shall be marked 60,000 lb. tensile strength and in building the boiler the plates shall be so placed that these stamps are plainly visible on the outside. These plates shall have the full specified thickness at the edges and shall meet the tensile, quenching and bend tests described.

The tubes shall be standard quality lap welded mild steel of standard manufacture. The thickness of the metal shall be 12 B.w.g. for 3-in. tubes, 11 B.w.g. for 3½-in. tubes and 10 B.w.g. for 4-in. tubes.

The rivets shall be of boiler-rivet steel as described in the standard specifications of the Association of American Steel Manufacturers and of proper size to suit the size of the hole and the thickness of the plates and to form up heads equal in strength to the pressed heads of same.

The diagonal braces shall be weldless of the same quality as the flange steel previously described and pressed from the solid plate, or else forged from steel bars. The number of braces to be used shall be computed on an allowance of not more than 7500 lb. of load per square inch of section of brace neglecting, in this, the inherent strength of the heads and the slight angularity of the braces.

Suitable through rods and braces shall be installed below the tubes when necessary to sustain the pressure. These shall be of steel and shall be computed with the same allowance as diagonal braces.

Braces as above described shall be carefully placed so that the pressure on the flat surfaces, both above and below the tubes, shall be as nearly equally distributed as possible.

For any boiler head the area to be supported by braces shall be the surface included within lines drawn 2 in. from the outside of the tubes and 3 in. from the inside of the shell.

DESIGN

The longitudinal seam of the shell shall be of the butt-joint type having inside and outside covering strips and either double, triple or quadruple riveted as indicated in Table 1*.

The circumferential seams shall be of the lap type of joint and single riveted.

In all joints the size, number and spacing of the rivets shall be such as to provide the strength necessary to maintain the factor of safety of five.

The tubes shall be placed in vertical and horizontal rows with ample space between the adjacent tubes and also between tubes and shell for the circulation of water and also with a large steam space above the water line.

Boilers 44 in. or less in diameter shall have a manhole above the tubes and a handhole below the tubes. These may both be in the front head or the handhole may be in the front head and the manhole in the back head. Boilers 48 in. in diameter shall have two manholes, both in the heads, one above the tubes and one below the tubes. They may both be in the front head or one manhole may be in the front head below the tubes and the other in the back head above the tubes. Boilers larger than 48 in. shall have two manholes, one of which shall be in the front end below the tubes, the other shall be above the tubes in either head or preferably may be placed in the shell.

The opening in the manhole shall not be less than 10x15 in. Each manhole shall be equipped with a heavy plate, bale, bolt, nut and gasket.

TABLE 1. DIMENSIONS FOR STANDARD RETURN-TUBULAR BOILERS

		Horsepower of Boiler as Rated	Diameter of Boiler, In.	Length of Tubes, Ft.	Number of 3½-in. Tubes	Number of 4-in. Tubes	Tube Heating Surface with 3½-in. Tubes, Sq.Ft.	Tube Heating Surface with 4-in. Tubes, Sq.Ft.	Shell Heating Surface Sq.Ft.	Thickness of Shell, In.	Thickness of Heads, In.	Width of Grates, In.	Length of Grates, In.	Area of Grates, Sq.Ft.	Diameter of Stack, In.	Length of Stack, Ft.	Gage of Stack	Length of Guys, Ft.	Diameter of Guys, In.	Size of Steam Opening, In.	Size of Pop Safety Valve, In.	Size of Water Gage Glass, In.	Size of Water Column Connections, In.	Size of Gage Cocks, In.	Size of Blow-off, In.	Size of Feed and Check Valves, In.	Size of Steam Gage Dial, In.
100 lb. Working Pressure	Longitudinal Seams, All Butt Jointed—Double Riveted	70	54	16	44	36	645.1	603.2	150.8	5/16	7/16	54	54	20.25	26	60	16	600	1/4	3½	2½	¾	1¼	¾	2	1¼	5
		80	60	16	54	44	791.7	737.2	167.6	5/16	7/16	60	54	22.5	28	60	14	600	5/16	4	2½	¾	1¼	¾	2	1¼	5
		90	60	18	54	44	890.6	829.4	188.5	5/16	7/16	60	60	25.0	28	60	14	600	5/16	5	3	¾	1¼	¾	2	1½	5
		100	66	16	66	54	967.6	904.8	184.3	11/32	7/16	66	54	24.75	30	60	14	600	5/16	5	3	¾	1¼	¾	2	1½	5
		110	66	18	66	54	1088.6	1017.9	207.4	11/32	7/16	66	60	27.5	30	60	14	600	5/16	5	3	¾	1¼	¾	2	1½	5
		125	72	16	86	70	1260.8	1172.9	201.1	11/32	7/16	72	54	27.0	34	60	14	600	5/16	5	4	¾	1¼	¾	2	1½	5
		150	72	18	86	70	1418.4	1319.5	226.2	11/32	7/16	72	60	30.0	34	60	14	600	5/16	6	4	¾	1¼	¾	2	1½	5
		165	72	20	86	70	1576.0	1466.0	251.3	11/32	7/16	72	66	33.0	34	70	14	700	5/16	6	4	¾	1¼	¾	2	1½	5
		180	78	18	110	88	1814.0	1658.8	245.2	11/32	7/16	78	60	32.5	38	60	12	600	5/16	6	4	¾	1¼	¾	2	1½	5
		200	78	20	110	88	2015.9	1843.1	272.4	11/32	7/16	78	66	35.75	38	70	12	700	5/16	6	4	¾	1¼	¾	2	1½	5
125 lb. Working Pressure	Longitudinal Seams, All Butt Jointed—Triple Riveted	70	54	16	44	36	645.1	603.2	150.8	11/32	7/16	54	54	20.25	26	60	16	600	1/4	3½	2½	¾	1¼	¾	2	1¼	5
		80	60	16	54	44	791.7	737.2	167.6	11/32	7/16	60	54	22.5	28	60	14	600	5/16	4	2½	¾	1¼	¾	2	1¼	5
		90	60	18	54	44	890.6	829.4	188.5	11/32	7/16	60	60	25.0	28	60	14	600	5/16	5	3	¾	1¼	¾	2	1½	5
		100	66	16	66	54	967.6	904.8	184.3	11/32	7/16	66	54	24.75	30	60	14	600	5/16	5	3	¾	1¼	¾	2	1½	5
		110	66	18	66	54	1088.6	1017.9	207.4	11/32	7/16	66	60	27.5	30	60	14	600	5/16	5	3	¾	1¼	¾	2	1½	5
		125	72	16	86	70	1260.8	1172.9	201.1	11/32	7/16	72	54	27.0	34	60	14	600	5/16	5	4	¾	1¼	¾	2	1½	5
		150	72	18	86	70	1418.4	1319.5	226.2	11/32	7/16	72	60	30.0	34	60	14	600	5/16	6	4	¾	1¼	¾	2	1½	5
		165	72	20	86	70	1576.0	1466.0	251.3	11/32	7/16	72	66	33.0	34	70	14	700	5/16	6	4	¾	1¼	¾	2	1½	5
		180	78	18	110	88	1814.0	1658.8	245.2	11/32	7/16	78	60	32.5	38	60	12	600	5/16	6	4	¾	1¼	¾	2	1½	5
		200	78	20	110	88	2015.9	1843.1	272.4	11/32	7/16	78	66	35.75	38	70	12	700	5/16	6	4	¾	1¼	¾	2	1½	5
150 lb. Working Pressure	Longitudinal Seams, All Butt Jointed—Quadruple Riveted	70	54	16	44	36	645.1	603.2	150.8	3/8	7/16	54	54	20.25	26	60	16	600	1/4	3½	2½	¾	1¼	¾	2	1¼	5
		80	60	16	54	44	791.7	737.2	167.6	3/8	7/16	60	54	22.5	28	60	14	600	5/16	4	2½	¾	1¼	¾	2	1¼	5
		90	60	18	54	44	890.6	829.4	188.5	3/8	7/16	60	60	25.0	28	60	14	600	5/16	5	3	¾	1¼	¾	2	1½	5
		100	66	16	66	54	967.6	904.8	184.3	3/8	7/16	66	54	24.75	30	60	14	600	5/16	5	3	¾	1¼	¾	2	1½	5
		110	66	18	66	54	1088.6	1017.9	207.4	3/8	7/16	66	60	27.5	30	60	14	600	5/16	5	3	¾	1¼	¾	2	1½	5
		125	72	16	86	70	1260.8	1172.9	201.1	3/8	7/16	72	54	27.0	34	60	14	600	5/16	5	4	¾	1¼	¾	2	1½	5
		150	72	18	86	70	1418.4	1319.5	226.2	3/8	7/16	72	60	30.0	34	60	14	600	5/16	6	4	¾	1¼	¾	2½	1½	5
		165	72	20	86	70	1576.0	1466.0	251.3	3/8	7/16	72	66	33.0	34	70	14	700	5/16	6	4	¾	1¼	¾	2½	1½	5
		180	78	18	110	88	1814.0	1658.8	245.2	13/32	7/16	78	60	32.5	38	60	12	600	5/16	6	4	¾	1¼	¾	2½	2	5
		200	78	20	110	88	2015.9	1843.1	272.4	13/32	7/16	78	66	35.75	38	70	12	700	5/16	6	4	¾	1¼	¾	2½	2	5

Size of Trimmings

Manholes placed in the shell shall be properly reinforced with a suitable steel saddle.

All openings 2 in. in diameter or larger shall have suitable steel reinforcing flanges riveted on. Cast-iron flanges or nozzles shall not be used.

Boilers for 125 to 150 lb. working pressure shall have the feed opening in the front head over the tubes and same shall be provided with a brass bushing and an internal feed pipe extending from the front end of the boiler to within about 3 ft. of the rear head, thence across to the side of the shell terminating in an elbow for discharge below the top row of tubes.

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*The butt type of joint is specified because the lap joint has been proved dangerous when used for the longitudinal seams. Defects in the lap seam usually develop where the parts are hidden. Inspection cannot reveal them. Domes are not specified because they are mechanically bad and are not necessary. The fixed, or "plug hat" type of dome is awkward at best, it tends to weaken the boiler and frequently makes the use of the lap type of joint necessary on the longitudinal seam.

The independent type of dome can be used on any boiler, but it will probably be found to be better engineering to apply it in the form of a steam separator near the engine throttle instead of as a dome near the boiler.

The manufacturers who have adopted these specifications do not recommend domes, or lap joints when used on longitudinal seams.

Boilers for 100 lb. working pressure shall be arranged to feed through the blowoff connection and the internal feed pipe be omitted.

Each boiler shall be provided with four steel lugs or brackets, two on each side for supporting the boiler, except that boilers 78 in. in diameter or boilers 20 ft. long shall be provided with eight such lugs, four on each side of the boiler and all of them arranged in pairs.

WORKMANSHIP

All rivet holes, and all tube holes shall be either drilled from the solid or punched small and reamed to size. After drilling or reaming the plates shall be taken apart and all burrs removed and the tube holes chamfered with a rose reamer.

The edges of the plates shall be beveled to an accurate caulking edge and after being riveted shall be caulked tight with a round nose tool.

The tubes shall be carefully placed, expanded tight in the heads with a roller expander and the ends carefully beaded over against the head at both ends.

WATER COLUMN

The water column shall be provided with three gage-cocks and shall be so placed that the lowest gage-cock shall be 2 in. above the tops of the uppermost row of tubes. The middle gage-cock shall be 3 in. and the uppermost gage-cock 6 in. above the lowest gage-cock measured vertically.

TESTS

All material used in the construction of the boiler shall be rigidly tested as called for in the above specifications and the completed boiler shall be subjected to a steady water pressure 50 per cent. above its proposed working pressure and made tight.

When specially requested the boiler manufacturer will furnish copies of the record of tests of the plates as made by the steel manufacturers. These reports shall be deemed sufficient indication of the quality of steel used.

EQUIPMENT

A complete standard boiler equipment includes: The bare boiler with lugs; cast-iron front with anchors; grate bars with bearers; rear arch bars; rear ashpit door and frame; safety valve with nipple to connect it to boiler; steam gage with siphon; water column with gage-glass, three gage-cocks and pipe connections to boiler; blowoff valve; check valve; stop valve for water feed line; smoke stack and guys; stacks less than 60 ft. long shall have four guy eyes, and guys six times as long as the stacks. Stacks 60 ft. long or longer shall have six guy eyes, two sets of three, and guys ten times as long as the stack. A stack plate or nozzle shall be included with each full-front boiler.

Of course, where boilers built according to the foregoing specifications are not legally satisfactory necessary modification is made.

Minimizing the Damage

A short time ago a tube burst on a 550-hp. Stirling boiler, writes J. A. Fritz in the American Gas & Electric Co.'s *Bulletin,* and while it did no great damage, it might interest the readers to know what means we are taking to minimize the damage, should a like accident occur.

This boiler was equipped with Babcock & Wilcox balanced fire-doors swinging inward. The tube that burst was in the row next to the fire, and while the automatic stop and check valve on the boiler operated at once, the escaping steam from the burst tube built up sufficient pressure inside the walls of the boiler setting to blow down the first baffle wall and bulge out the front of the boiler about 3 in. At the same time it blew off about half of the bricks on top of the boiler, which relieved the pressure and the damage was stopped. Luckily no one was hurt as the fireman had just stepped to one side of the boiler and the escaping steam and water around the fire-doors did not reach him.

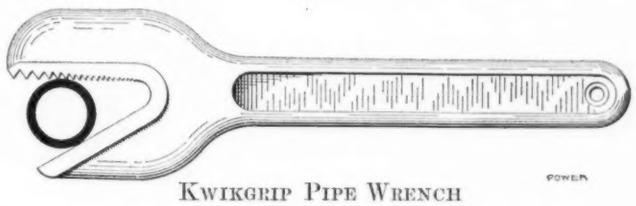
When we rebricked the setting we left a hole about 3 ft. square on the top of the boiler, which we covered with a ¼-in. plate with a layer of asbestos on it. This being light will lift readily, relieve the pressure, and save the setting in the event of another occurrence of a similar nature.

We intend to equip all our boilers in this way, as we feel that an explosion door of some kind is necessary when the fire-doors open inwardly (which is the only way any fire-door should open) as it can readily be seen that the more nearly equal in strength the walls of the setting may be, the more severe will be the damage.

The result of this explosion emphasizes another fact, that all boilers should be equipped with stop and check valves, as in this case the hole blown in the top of the boiler setting was just where a man would have to stand to shut off the stop valve to the boiler. Had the automatic valve not operated he could not have closed the other valve and this might have meant a complete shutdown, as a pressure of 150 lb. blowing to the atmosphere through a 3¼-in. hole would soon fill a boiler room so full of steam that it would be impossible to get to any valves on the boilers, especially if the boiler house had a low roof.

"Kwikgrip" Pipe Wrench

This wrench differs from others, in that it is made with a straight, tempered jaw of vanadium steel. As indicated, the toothed jaw is in alignment with the handle and, therefore, is in line with the force of application. The smooth jaw is at an angle from the handle and receives the entire impact of the force of application and, by reacting from the smooth jaw the full force of the impact is forced to the teeth which locks the wrench to the pipe.



KWIKGRIP PIPE WRENCH

The steel teeth are graduated and are made of the proper size to fit various sizes of pipe. The large teeth are in the outer end of the jaw for gripping large pipes, and small teeth, at the inner end of the jaw, for small pipes.

The point of application of the toothed jaw is at the top center of the pipe, as shown. This is also the pivoting point of the turning force and as the handle is in alignment with the toothed jaw, the greater turning force applied to the handle the more firmly the teeth grip the pipe.

This wrench is made in seven sizes by the Prince-Groff Co., 18-22 George St., Camden, N. J. It is easily applied to the pipe in any position and the tempered teeth stay sharp for a long time.

Increased Use of Locomotive Superheaters—There was recently held at Cassel-Wilhelmshöhe a celebration to commemorate the equipment of the 25,000th locomotive with the Schmidt system of superheating, which has now become a standard and increasingly popular feature of locomotive practice. Dr. Schmidt's first superheater to be applied to locomotives was installed in 1898 on some engines of the Prussian State Rys. Schmidt's pioneer work and its success encouraged competition.

ELECTRICAL DEPARTMENT

Current Rectifiers

By John A. Randolph

There are, in general, six types of apparatus used for converting alternating current into direct, namely; the rotary converter, the motor-generator, the rectifying commutator, the aluminum-valve rectifier, the vibratory type and the mercury-arc rectifier. The most widely used of these are the rotary converter, the motor-generator and the mercury-arc rectifier. The others are more or less limited in their application, hence are not so generally employed.

The rotary converter and the motor-generator are the machines most commonly used for the conversion of currents in large quantities. The former is generally employed, but the latter is preferable under certain conditions. One advantage which the motor-generator possesses, when its motor is of the induction type, is its continuity of operation under fluctuations of voltage. It will continue to operate safely on a variable alternating-current pressure with little necessity for attention on the part of the operator. Moreover, if the power supply should be momentarily interrupted and return quickly, the motor will at once take up its work again without causing the inconvenience of a special starting procedure. The rotary converter, on the other hand, being a synchronous machine, may fall out of step, under such a contingency, and thereby require the time and inconvenience incident to synchronizing again before it can continue its operation.

Another advantage of the motor-generator is its independent direct-current voltage control. The direct-current end of the machine being entirely separate electrically from the alternating-current end, the direct-current voltage may be varied at will without recourse to a corresponding variation in the alternating-current pressure. Also, it possesses an advantage in that, by the use of a high-voltage motor, it may be connected directly to a high-tension supply without the use of transformers.

Under the conditions most commonly encountered, however, the rotary converter is much to be preferred to the motor-generator. In the first place, its first cost is lower and its efficiency higher in that it consists of but one machine instead of two. Moreover, the floor space which it occupies is smaller. The moving parts and windings are less in number, thereby rendering repairing and renewals less frequent. The general attention required is also less on account of its compactness.

Rectifying Commutator

This method, shown in Fig. 1, is used principally in connection with composite field excitation of alternators. In this case the commutator is mounted on an extension of the armature shaft. If separately driven it must be at a speed synchronous with the alternating-current supply. The number of segments corresponds to the number of field poles of the alternator. All segments of even number are connected together as are also the odd-numbered segments. From one of these common connections a lead is run to the armature circuit and from the other to one of the slip rings, as shown. The two brushes are so spaced that one makes contact with an odd-numbered

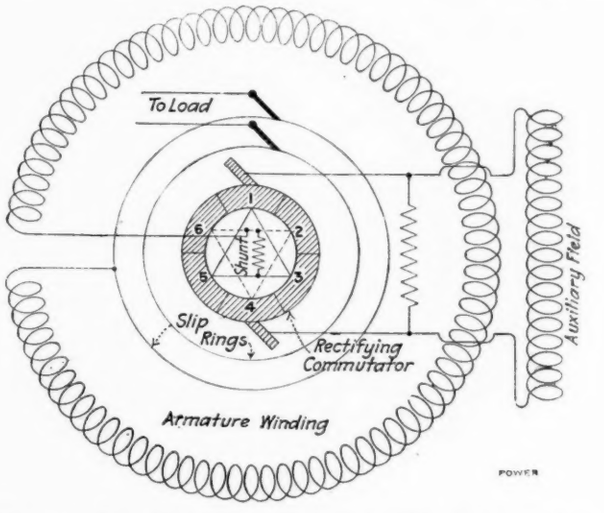


Fig. 1. Connections for Rectifying Commutator

segment at the same time that the other is bearing upon a segment of even number. The commutator moves forward one space or segment with each reversal of current following the movement of the armature coils from pole to pole. This causes each commutator brush to bear alternately upon the two sets of segments, in synchronism with the reversal of current in the armature. By tracing the current flow, it will be seen that the current passing through the circuit leading from the commutator brushes can flow in but one direction. A shunt can be used in case it is desired to rectify but a part of the current.

Aluminum-Valve Rectifier

This type makes use of the principle that aluminum plates or electrodes in certain solutions will allow current to pass through them in but one direction, namely, inwardly from the solution. The aluminum plates can therefore be used only as cathodes or negative plates to which the current flows within the rectifier. Two aluminum electrodes and one of iron are immersed in a neutral solution of ammonium phosphate, as shown in Fig. 2. The iron plate comprises the anode or positive plate from which the current flows within the rectifier. The cathodes are each connected to a terminal of a transformer while the iron anode is connected to one terminal of the battery to be charged. The other battery terminal is connected to the middle point of an auto-transformer connected across the two secondary leads from the supply transformer, as shown. At a moment when the terminal *A* of the supply transformer is positive, the current will flow as shown by the solid arrows. The cathode *C* will not allow current to flow through it in this direction be-

cause of a film of aluminum oxide on its surface which up to a pressure of 150 volts offers a very high resistance to currents tending to flow in this direction. The current, therefore, flows to the point *E* where it is forced toward the battery, owing to the fact that the other half *H* of the auto-transformer, acting as the secondary of a transformer of which the coil *G* is the primary, establishes a pressure acting toward the point *E* which prevents the current from flowing beyond *E* and through the coil *H*. Moreover, the coil *H* sets up a current toward *E* which is of the same magnitude as that in coil *G* and is added to it. The combined currents flow through the battery to the iron anode, thence to the cathode *D* from which they flow to the terminal *F* of the auto-transformer where the portion supplied by coil *H* is diverted to the coil to complete its circuit. The main current continues to terminal *B* of the supply transformer.

In the next half period, when the direction of current in the supply mains is reversed, the path through the rectifier and battery will be as shown by the dotted arrows. The plate *C* now becomes the active cathode.

This type of rectifier is limited on the direct-current side to a voltage of approximately 55 and a current of about 25 amp., owing to the heating tendency of the cell. It also has a disadvantage in that its efficiency is low. On account of its limitations and comparatively high cost of operation, it has not come into general use.

The Vibratory Rectifier

This type is often used for charging ignition and lighting batteries on automobiles and for other purposes requiring only a small current. Two types are made; one

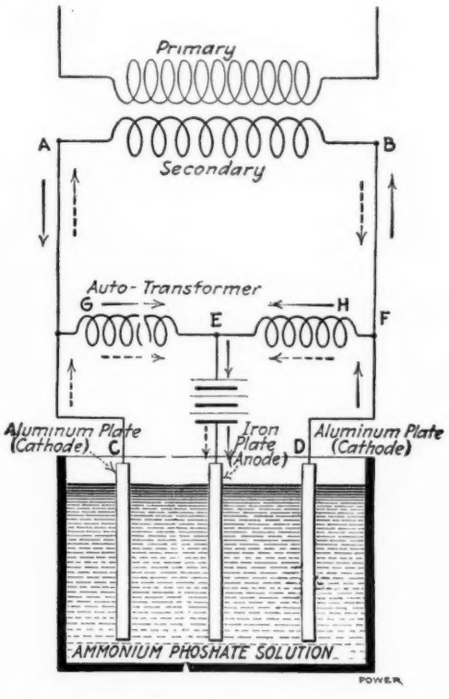


Fig. 2. Aluminium-Valve Rectifier

utilizes but a single wave of each alternating-current cycle while the other utilizes both waves. In the former or single-vibrator type there is a solenoid which acts upon a vibrator or spring. Connections are so made that when the alternating-current wave is in one direction, the spring armature is attracted by the solenoid, and makes contacts such that the current of a high portion of the wave is utilized by the battery. In the next half cycle, however, when the current is reversed, the armature is released, stopping the flow of current in the charging circuit until the next reversal of alternating

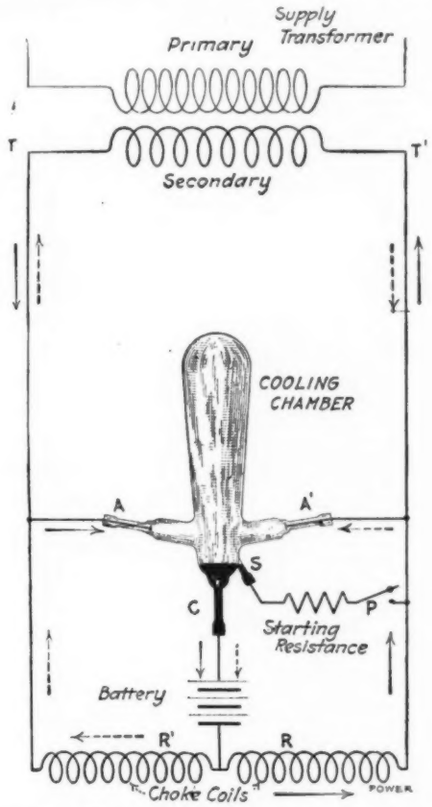


Fig. 3. Mercury-Vapor Arc Rectifier

current when the wave takes the same direction as at first.

In the double-vibrator type, two solenoids are used with either a separate vibrator for each solenoid or one vibrator in common for both. Connections are so made with the solenoids and vibrator-controlled contacts that both halves of the alternating-current cycle are utilized.

The vibratory rectifiers are low in capacity and can therefore be readily connected by lamp cord and plug to an incandescent-lamp socket. Their small size and light weight renders them easily portable, thus affording a ready means of charging the battery when only an alternating-current supply source is available.

The Mercury-Vapor Arc Rectifier

This is the type of rectifier most commonly used in cases where the rotary converter or motor generator is not employed. It consists primarily of a glass bulb from which the air has been exhausted and which contains two anodes usually of graphite and a cathode of mercury.

The operation depends upon a check-valve tendency of the mercury cathode whereby current can flow through it in but one direction, namely, from the anodes. This is due to a high resistance which develops at the surface of the cathode pool at the slightest interruption of the current. Therefore, if a current passing through the cathode from an anode were to drop to zero and tend to change its direction, as in an alternating-current cycle, it would at once encounter the cathode resistance and be stopped.

The current is enabled to pass through the bulb, when maintained in the proper direction, by means of mercury vapor which, during operation, completely fills the bulb.

The connections for a rectifier of this type are shown in Fig. 3; A and A' are the graphite anodes, C the mercury cathode, and S a starting anode at which is also a pool of mercury, but in a smaller quantity than at the cathode.

In starting, the single-pole switch P is closed and the bulb tilted until the two mercury pools come together. The bulb is then rocked backward so that the mercury pools fall apart, drawing an arc as they recede. This breaks down the resistance existing at the surface of the cathode pool while cold, and thereby causes mercury vapor to form. The latter fills the bulb and comes into contact with the anodes, thereby causing the rectifying action of the bulb to start. The single-pole switch P is now opened. The current required for starting is small and is regulated by the resistance shown in series with the starting anode.

At a moment when the terminal T of the supply transformer is positive, the direction of current flow will be as shown by the solid arrows. It enters the tube by anode A, leaves by cathode C, passes to the load and thence to the choke coil R whence it flows back to the transformer. At the next instant, when the reversal in alternating current takes place, A' will become the active anode. However, as an alternating current passes through zero in changing its direction to accord with the second half of the cycle, the arc between either anode and cathode must have an auxiliary force to sustain it until the pressure in the second half cycle has risen to a value sufficient to establish an arc from the other anode. If the arc were not thus sustained, it would cease and thereby stop the action of the bulb. Two choke coils are used for this purpose, one for each anode. When the current flow is changing from anode A to A' the arc hitherto existing between A and C is maintained by the self-inductive action of the choke coil R which upholds the arc until the current flow is established from the anode A'. The direction of current is now as shown by the dotted arrows. Leaving the terminal T' the current flows through the rectifier by way of anode A' and cathode C, thence passing through the load and choke coil R' to the transformer terminal T. The arc is sustained at the next reversal by the choke coil R'.

The mercury-vapor arc rectifier is commonly used on single-phase circuits. The voltage drop in the rectifier ranges from 14 to 25 volts, depending upon the purpose for which the rectifier is used. The current limit for which glass bulbs can be made is about 50 amp.

The life of the bulbs is at least 500 hr. under normal conditions and with careful usage is likely to be much longer. The size and shape of the bulb are dependent upon the voltage to be used and upon the current which it is to carry. If the voltage is to be high, careful precautions should be observed in placing the anodes. They should be so arranged that they cannot be short-circuited by spatterings of mercury which would allow the current to jump across and stop the operation. Short-circuits of this nature are also likely to damage the bulb. The cross-sectional area of the bulb must be larger for heavy currents than for those of lower value in order that the volume of mercury vapor may be sufficient to carry the load. The size of the cooling chamber is also dependent upon the capacity of the rectifier. The greater the quantity of mercury vapor formed, the larger should be the cooling chamber in order to prevent overheating and also to accomplish the condensation with sufficient rapidity.

Standard rectifier outfits are usually designed for an alternating-current frequency of 60 cycles, but they can be adapted to frequencies ranging from 25 to 140 cycles. The power factor of the system is about 90 per cent. under normal conditions. The efficiency ranges from 75 to 80 per cent., depending upon the direct-current voltage carried, the efficiency increasing with the voltage.

Uses of the Mercury-Vapor Arc Rectifier

The most important purpose for which this rectifier is used is battery charging in connection with automobiles, telegraph systems, annunciators, motor boats and other apparatus or systems making use of batteries of small capacity. It can be readily adjusted to any number of cells within standard limits by taps on the transformer. Its next most important field is arc lighting. It is here used to operate constant-current series arc-lighting systems and also to supply direct current for the arc lights used in moving-picture machines. It is used for the latter purpose because of the superiority of the direct-current arc over that supplied by alternating currents, for this class of work. This is because in the alternating-current arc the light is distributed over the whole arc while in the direct-current arc, it is concentrated at one point, namely, the crater on the positive carbon. The concentration of the light source renders the projection of the emanating rays through a lens more satisfactory than with the alternating-current arc. The mercury-vapor arc rectifier is also used for laboratory work, electrolytic processes and other purposes where small direct currents are required.

The comparatively low first cost, ease of operation, fairly high efficiency, and the relatively wide range for adjustment of currents and voltages are some of the more important advantages of this type over other forms. Other points in its favor are the small space which it occupies and its freedom from moving parts which would require constant attention and care.

An English Engineer's Viewpoint—In his inaugural address, Chairman Vernier of the Newcastle Section, Institution of Electrical Engineers, in reviewing the status of electrical development in England, paid a high compliment to the progress made in these lines in this country. His remarks were in part as follows:

"The hindrances to our progress are by no means technical in character, and it is true that the world's achievements in electrical and mechanical engineering are far in advance of any of the possible requirements of this country (England) for many years to come. When we learn, as from the United States, of 30,000-kw. turbo-generators, of which seven are already under construction, the daily operation of high-voltage overhead transmission up to 140,000 volts and covering distances up to 240 miles, of 300,000-hp. central-station developments and the electrification of some hundreds of miles of main-line railway, we need have no fear as to the ability of engineers to keep pace with the world's industrial demands. But, for ourselves, can we ever hope to maintain our position in the electrical engineering world if we are content to allow our electric supply industry to develop along its narrow way; indeed, have we not already lost too much ground? What training ground shall we offer the rising generation of British electrical engineers if we wish to take our part in the electrical development of our Empire over seas, and how shall our electrical manufacturers assume their proper place in the markets of the world when handicapped at home by a restricted market, which might easily be increased to many times its present proportions?"

GAS POWER DEPARTMENT

Fuels for Diesel Engines*

The following points relative to oil fuel are taken from a report of Alfred Büchi in "Zeitschrift des Vereines Deutscher Ingenieure." They are concerned chiefly with data in the matter of low-volatile oils and of their properties as determining their suitability for use in Diesel engines, as well as with the development of the Sulzer type of that engine into large power units.

Regarding the fitness of fuel for Diesel-engine operation the principal factors are heat value, viscosity, volatility and percentages of ash, sulphur, water, free carbon, coke, etc. Comparison is made in the accompanying chart of such properties of fuels of low volatility as are mainly taken into account for the operation of Diesel engines.

Line 1 shows the range of minimum heat values; the cheaper fuels especially appearing much lower in that respect than the more expensive gas and paraffin oils, a point to be kept in mind in considering prices. Gas oil has a heat value per pound of 18,000 or more B.t.u., and coal oil from about 15,500 to 16,600; while in a pound of tar from the horizontal type of retort there is an average of but 14,800 B.t.u. Similar fuels also show a fluctuation of heat values; this dropping notably in the presence of a greater water content.

Line 2 gives the specific gravities which increase with the heat value.

Line 3 shows the viscosity as dependent on the temperature and points out for given cases the greater or lesser need for warming the fuel prior to introduction into the engine cylinder. While the viscosity of the first three fuels differs but little from that of water, the last four are very high, and with them preheating is necessary; this should be extended to between 140 and 175 deg. F. to assure their uninterrupted flow to the fuel pump and the injection valve. From the last column it is evident that the degree and variability of viscosity of the tar obtained from horizontal retorts militates strongly against its use.

In line 4 are given the approximate temperatures of solidification of the different fuels under consideration. These temperatures are mostly below 32 deg. F.; the tars, however, due to their high viscosity, begin to form pasty masses at relatively high temperatures.

Line 5 gives evaporation curves for different temperatures. Oils which contain easily evaporated elements are more readily ignited in the cylinder. Failing in ease of evaporation it becomes necessary to increase their inflammability by other means, for instance, through temperature rise, and it then becomes compulsory to introduce beforehand some special oil for ignition, such as the readily inflammable gas and paraffin oils. Such addition amounts to about 5 to 10 per cent. of the operating fuel, but continuous operation with tar oil has been accomplished without this addition. The chart shows that coal-tar oil is lacking in constituents vaporizable at low temperature, and a curve (in dotted line) is added to show that its volatile properties vary greatly with its composition. The tars contain more of such elements than do the tar oils, as is also evident from the curves and as borne out by practical investigations of their use in prime movers.

The data from an average elementary analysis as presented in line 6 show the carbon and hydrogen as the mean of a series of analyses; the remaining constituents are grouped. It is characteristic of gas oil and of paraffin oil that their content of hydrogen is relatively high as compared with that of oils and tars yielded by bituminous coals. Hydrogen raises the heat value and fuels rich in that element produce a more powerful cylinder ignition.

The ash content, line 7, is important with liquid fuels only in the case of those recovered from bituminous coals. It can, of course, make itself disturbingly noticeable with Masut, the residue of naphtha distillation. Ash has a harmful effect on the valves and pistons and may also tend to clog the piping.

The sulphur percentage, line 8, is more or less a detriment, especially in the presence of water; sulphuric or sulphurous acid results with consequent engine corrosion.

A small water content in the fuel is not directly injurious, merely lowering the heat value. However, if the amount be greater than 0.5 to 1 per cent.; see line 9, the continuity of ignition may be interrupted. Leaving such fuel standing for some time separates the water, though this can be accomplished more quickly by centrifugal action.

Lines 10 and 11 give, respectively, the contents of free carbon and coke which play an important part in the adapability of the fuel as they can also unfavorably affect the life of the pistons, valves, etc., and the working efficiency of the engine. For the tars from inclined and horizontal retorts these values are almost prohibitively high. When these two components are materially lessened in amount the use of gas tars can be assured, as it is these alone which still present difficulties in that direction.

Concerning the field of usefulness of crude tar from inclined retorts, as furnished by gas works, practical tests have already been made with a four-stroke-cycle Diesel engine of 800 hp. built by Sulzer Brothers in 1908 for the St. Gallen, Switzerland, water-works; a continuous run of eight full days under normal duty having been maintained. In comparison with the use of gas oil there was, however, a greater wear of the exhaust valves. With a two-stroke-cycle engine where the exhaust is through ports in the cylinder walls and controlled by the main piston the condition would not obtain. The test showed that with a greater allowance for depreciation, operation with tar from inclined retorts is practicable and the St. Gallen gas works are enjoying a very considerable saving thereby. This plant serves a city of about 50,000 in-

*Translated by W. F. Monaghan.

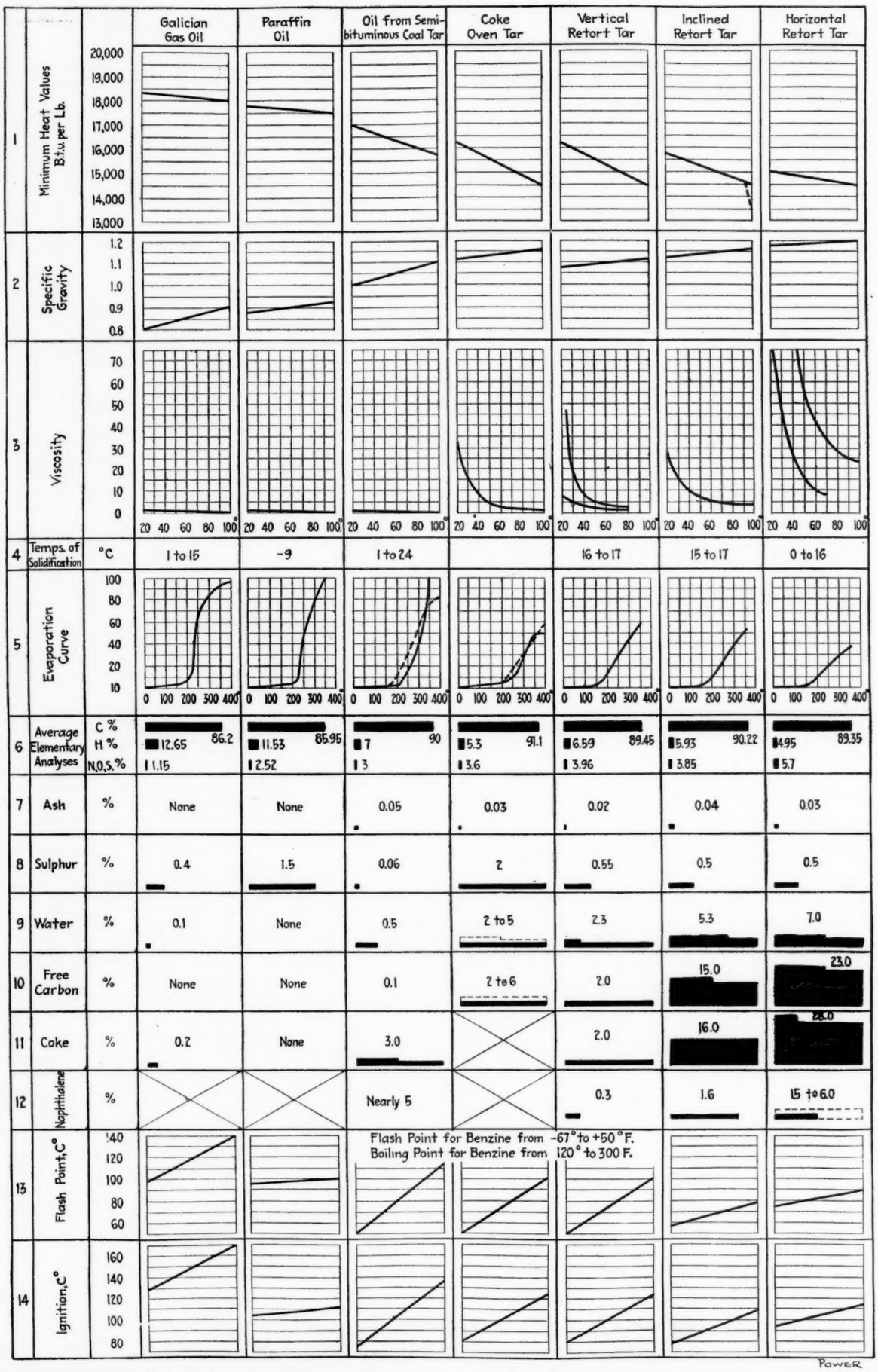

Galician Gas Oil
Paraffin Oil
Oil from Semi-bituminous Coal Tar
Coke Oven Tar
Vertical Retort Tar
Inclined Retort Tar
Horizontal Retort Tar
1 Minimum Heat Values B.t.u. per Lb.
20,000 19,000 18,000 17,000 16,000 15,000 14,000 13,000
2 Specific Gravity
1.2 1.1 1.0 0.9 0.8
3 Viscosity
70 60 50 40 30 20 10 0
20 40 60 80 100°
4 Temps. of Solidification °C
1 to 15
-9
1 to 24
16 to 17
15 to 17
0 to 16
5 Evaporation Curve
100 80 60 40 20 10
0 100 200 300 400°
6 Average Elementary Analyses
C % 86.2 85.95 90 91.1 89.45 90.22 89.35
H % 12.65 11.53 7 5.3 6.59 5.93 4.95
N,O,S.% 1.15 2.52 3 3.6 3.96 3.85 5.7
7 Ash %
None None 0.05 0.03 0.02 0.04 0.03
8 Sulphur %
0.4 1.5 0.06 2 0.55 0.5 0.5
9 Water %
0.1 None 0.5 2 to 5 2.3 5.3 7.0
10 Free Carbon %
None None 0.1 2 to 6 2.0 15.0 23.0
11 Coke %
0.2 None 3.0 2.0 16.0 28.0
12 Naphthalene %
Nearly 5 0.3 1.6 1.5 to 6.0
13 Flash Point, C°
140 120 100 80 60
Flash Point for Benzine from -67° to +50° F.
Boiling Point for Benzine from 120° to 300 F.
14 Ignition, C°
160 140 120 100 80
POWER

CHART SHOWING COMPARATIVE PROPERTIES OF DIESEL ENGINE FUELS

habitants and has a yearly byproduct of tar of about 1500 tons, yielding, at $4.76 a ton, a return of $7140. But with this quantity of tar it would be possible also to generate four million kilowatt-hours, for which, if tar oil were used, about 1320 tons would be required, representing in cost nearly $17,400. Thus through the change from tar oil to tar an annual saving of over $10,200 is effected. If the depreciation charge were increased by, say, $2400, there would still remain a net yearly saving of over $7850; proving that a municipal administration would do well to utilize the tar from its gas works for power production.

The naphthalene content of tar oil and of gas-works tars is given in line 12. At low temperatures naphthalene crystallizes out and hence causes clogging of pipes, etc. In that case, as for the higher viscosities, preheating of such fuel is necessary.

The last two lines give the flash and ignition points, which are of moment in the matter of fire risk. They show that this factor is negligible with fuels used in Diesel engines, and for that reason the installation of such engines and of their fuel tanks is not subject to special legal supervision.

As seen from the foregoing, it is hard to say in advance whether this or that fuel is appropriate for Diesel-engine consumption. A knowledge of the physical and chemical properties does not suffice for all cases; hence a trial run is often requisite before the fitness of a fuel can be determined with certainty.

The Decline of Oil Wells

Technical Paper 51, by L. G. Huntley, just issued by the Bureau of Mines, comments upon the probable causes of the decline of oil wells. It points out that, in general, the yield of a well declines in one or both of two ways: Suddenly, after the initial spurt, due to local relief of pressure, or with relative slowness after the production has become settled.

The initial spurt, which in many cases represents the flowing period of a well's life, is due to a relief of the supersaturated condition of the sand. The sudden release of pressure results in a spurt of petroleum, usually in the form of an emulsion with spray, caused by the expansion of the contained gases, that lasts for a variable time. The duration of this period of high production depends on local conditions such as the porosity and structure of the sand, extent of the pool, rock pressure, etc.

The extent and rapidity of the succeeding decline is governed by several factors which may be classified as follows:

1. Formation of waxy sediments that obstruct the passage of oil from the sand.
2. Decline of gas pressure in the district.
3. Decrease in quantity of oil draining by gravity into the area affected by the well.
4. Decrease in oil supply within drainage area of well due to near-by developments.
5. Flooding by nonencroaching salt water under low pressure.
6. Flooding by salt water under high pressure.
7. Flooding by fresh water from the surface or from an overlying water-bearing formation.
8. Poor management, such as improper casing, unwise rate and time of pumping and failure to clean the well.

The author discusses in detail each of the foregoing causes. Of particular interest, however, is the decline due to the formation of waxy sediment. Petroleum in the so called paraffin-oil fields consists of hydrocarbons of the paraffin series, which range from the heaviest oil to the lightest gas. The gaseous constituents exist in what may be likened to a solution similar to the gas in a bottle of soda water, and as such expand and escape when the pressure is relieved by a well. The sudden expansion and volatilization of these light hydrocarbons has a refrigerating effect, like the expansion of ammonia in an ice machine, thus chilling the remainder of the liquid petroleum and causing the separation of the heaviest paraffin as an amorphous waxy sediment. This clogs the pores of the sand and obstructs the passage of the oil into the well.

Trouble with Magneto

A peculiar and unusual cause of trouble with a magneto recently came under my observation. The machine had been overhauled by a first-class machinist and all the adjustments were mechanically perfect; yet the output was only about 30 per cent. of what it should have been.

The insulation was carefully examined, as also were all the contacts. Tests were made for short-circuits, but the trouble could not be located. Finally, as the field seemed to be very weak, the compound horseshoe magnets were dismounted to see if they were losing their magnetism.

The magnets were found to be all right, but a simple test revealed the fact that one of them had been turned around so that its magnetism opposed that of the other two.

On reassembling the magnets in their correct position, the performance of the machine was entirely satisfactory.

B. Copping.

Kankakee, Ill.

Cleaning Producer Gas

Replying to F. D. Harger's inquiry in the Oct. 28 issue, on cleaning producer gas for purposes of analysis, we have analyzed such gas in the Orsat and the only filter used was cotton packed loosely in a glass tube about 6 in. long and ¾-in. or ⅞-in. bore with a stopper in each end in which was inserted a glass tube for the rubber-tube connections. The gas should be drawn or forced through a few feet of small pipe so it will become cooled.

If I had his problem to solve I would make a cotton filter of a size proportionate to the demand for gas. The cooler the gas enters the filtering material the better it will be filtered.

We have used for the past four years a filter 30 in. in diameter by 4 ft. high for the final cleaning of the gas before it passed into the cylinders of a 125-hp. engine. The filter had three trays on which were packed white waste with a layer of cotton batting on top of the waste in the top tray. I think a properly arranged filter with sawdust for the filtering material ought to give good results.

Anderson, Ind. J. O. Benefiel.

REFRIGERATION DEPARTMENT

Cost of Manufacture in Distilled-Water Ice Plants*

By Peter Neff

In general the manufacturing cost of ice per ton in any plant is the total amount expended during the year in its production divided by the number of tons of ice sold. Ideas as to what items are a legitimate charge will vary somewhat, but to my mind they are: Depreciation, repairs, insurance and taxes, labor, fuel and sundries (oil, waste, ammonia, salt, etc.)

The first three of these items may be termed the fixed charge. They are not dependent on the output, run over the entire year, and may even be greater when the plant is not producing. They are a large factor in the cost of production, and are often partially or totally omitted when thinking of the cost. The last three have a direct relationship to the output, and are the ones usually taken into account.

For the sake of convenience the output for 330 days was taken as a year's production, as all plants should have a period of shutdown for overhauling. Then three periods, varying by 50 days, viz., 280, 230 and 180, were taken as representing productive periods. This division is purely arbitrary, and has been used simply for convenience, but serves to cover the various productive periods as found in ice plants. While the computations herewith are based on ammonia-compression plants, in view of the fact that all the distilled water comes from the boilers they will apply equally well to absorption and to plants where other than ammonia is used for the refrigerant.

TABLE 1. INVESTMENT AND FIXED CHARGE IN DOLLARS FOR STANDARD DISTILLED-WATER ICE PLANTS

Daily Capacity of Plant in Tons	10	15	20	25	30	35	40	50	60	80	100
Buildings	4,000	5,000	6,000	6,700	8,000	9,500	10,500	11,500	12,500	15,500	19,000
Equipment	8,000	11,000	13,000	16,000	18,000	22,000	25,000	29,000	32,000	42,000	56,000
Investment	12,000	16,000	19,000	22,700	26,000	31,500	35,500	40,500	44,500	57,500	75,000
Fixed charges*	1,800	2,400	2,850	3,405	3,900	4,725	5,325	6,075	6,675	8,625	11,250

* Composed of 6 per cent. depreciation, 5 per cent. repairs, 4 per cent. insurance and taxes.

TABLE 2. TONS OF ICE PRODUCED AND FIXED CHARGE PER TON IN DOLLARS

Daily Capacity of Plant in Tons	10	15	20	25	30	35	40	50	60	80	100
Tonnage—180 days	1800	2700	3600	4500	5400	6,300	7,200	9,000	10,800	14,400	18,000
Charge per ton	1.00	0.89	0.79	0.76	0.72	0.75	0.74	0.68	0.62	0.60	0.63
Tonnage—230 days	2300	3450	4600	5750	6900	8,050	9,200	11,500	13,800	18,400	23,000
Charge per ton	0.78	0.70	0.62	0.59	0.57	0.59	0.58	0.53	0.48	0.47	0.49
Tonnage—280 days	2800	4200	5600	7000	8400	9,800	11,200	14,000	16,800	22,400	28,000
Charge per ton	0.64	0.57	0.51	0.49	0.47	0.48	0.48	0.43	0.40	0.39	0.40
Tonnage—330 days	3300	4950	6600	8250	9900	11,550	13,200	16,500	19,800	26,400	33,000
Charge per ton	0.55	0.49	0.43	0.41	0.39	0.41	0.40	0.37	0.34	0.33	0.34

TABLE 3. COST OF LABOR FOR STANDARD DISTILLED-WATER ICE PLANTS

Daily Capacity of Plant in Tons	10	15	20	25	35	40	50	60	80	100
Tankmen	3.50	3.50	4.00	4.00	4.00	4.00	4.00	4.00	4.00	8.00
Engineers	4.50	5.50	5.50	5.50	5.50	6.00	7.50	7.50	7.50	7.50
Firemen	....	....	3.50	4.00	4.00	4.00	4.00	4.00	6.00	8.00
Oilers	....	....	....	....	....	2.00	2.00	2.00	2.00	4.00
Housemen	....	....	....	....	....	....	....	4.00	4.00	4.00
Extra men	....	....	....	....	....	1.50	2.00	2.00	2.00	4.00
Net total	8.00	9.00	13.00	13.50	13.50	17.50	19.50	23.50	25.50	35.50
10 per cent.	0.80	0.90	1.30	1.35	1.35	1.75	1.95	2.35	2.55	3.55
Total daily	8.80	9.90	14.30	14.85	14.85	19.25	21.45	25.85	28.05	39.05
Labor per ton	0.88	0.66	0.72	0.60	0.50	0.48	0.43	0.43	0.35	0.39

TABLE 4. MANUFACTURING COST OF ICE PER TON AND AMOUNT OF ICE PRODUCED

Daily Capacity of Plant in Tons	10	15	20	25	30	35	40	50	60	80	100
180 Days Production											
Fuel	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Sundries	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Labor	0.88	0.66	0.72	0.60	0.50	0.49	0.48	0.43	0.43	0.35	0.39
Fixed charge	1.00	0.89	0.79	0.76	0.72	0.75	0.74	0.68	0.62	0.60	0.63
Total cost per ton	2.62	2.29	2.25	2.10	1.96	1.98	1.96	1.85	1.79	1.69	1.76
Tonnage for period	1800	2700	3600	4500	5400	6300	7200	9000	10,800	14,400	18,000
230 Days Production											
Fuel, sundries, labor	1.62	1.40	1.46	1.34	1.24	1.23	1.22	1.17	1.17	1.09	1.13
Fixed charge	0.78	0.70	0.62	0.59	0.57	0.59	0.58	0.53	0.48	0.47	0.49
Total cost per ton	2.40	2.10	2.08	1.93	1.81	1.82	1.80	1.70	1.65	1.56	1.62
Tonnage for period	2300	3450	4600	5750	6900	8050	9200	11,500	13,800	18,400	23,000
280 Days Production											
Fuel, sundries, labor	1.62	1.40	1.46	1.34	1.24	1.23	1.22	1.17	1.17	1.09	1.13
Fixed charge	0.64	0.57	0.51	0.49	0.47	0.48	0.48	0.43	0.40	0.39	0.40
Total cost per ton	2.26	1.97	1.97	1.83	1.71	1.71	1.70	1.60	1.57	1.48	1.53
Tonnage for period	2800	4200	5600	7000	8400	9800	11,200	14,000	16,800	22,400	28,000
330 Days Production											
Fuel, sundries, labor	1.62	1.40	1.46	1.34	1.24	1.23	1.22	1.17	1.17	1.09	1.13
Fixed charge	0.55	0.49	0.43	0.41	0.39	0.41	0.40	0.37	0.34	0.33	0.34
Total cost per ton	2.17	1.89	1.89	1.75	1.63	1.64	1.62	1.54	1.51	1.42	1.47
Tonnage for period	3300	4950	6600	8250	9900	11,550	13,200	16,500	19,800	26,400	33,000

The value of the land on which the plant is located is not taken into account, but must be considered and added to the figures here given to arrive at the total investment. It is further assumed that there is no charge for water, but that it is pumped by steam power, and this

*Abstract of paper read before the Third International Congress of Refrigeration.

steam is part of that taken from the boilers for distilled water.

Fixed Charges

Table 1 shows the cost of buildings, cost of equipment and the fixed charge. To obtain the cost of the buildings, dimensions as given by two of the manufacturing companies were taken, and the cost based on 8c. per cu.ft. of space inclosed. Nothing has been provided but the necessary equipment, and there will be variations in this item, but not sufficient to seriously affect the results. These two items give what is termed the investment.

Depreciation is that ordinarily adopted, viz., 6 per cent., which will return the cost of the investment in practically 17 years. This has been used both for the buildings and the equipment.

For repairs the 5 per cent. employed has been arrived at from the experience of others in various lines of manufacturing, and form a study of widely scattered ice plants. The 4 per cent. for taxes and insurance seemed to be a fair average.

The three foregoing items constitute what is termed the fixed charge. Table 2 shows how this effects the cost of the ice under the different periods of production, and is obtained by dividing 15 per cent. of the investment by the tonnage for the period indicated, the result being the charge per ton for that period.

TABLE 5. AMOUNT PER TON TO BE ADDED FOR ICE STORAGE TO MANUFACTURING COST FOR 330-DAY PERIOD

Daily Capacity of Plant in Tons	Tons of Ice Stored												
	1000	1500	2000	2500	3000	3500	4000	5000	6000	7000	8000	9000	10,000
10	0.15												
15	0.10	0.15											
20	0.07	0.11	0.15										
25	0.06	0.09	0.12	0.15									
30	0.05	0.075	0.10	0.125	0.15								
35	0.04+	0.06	0.09	0.11—	0.13	0.15							
40	0.04—	0.05	0.075	0.095	0.11	0.13	0.15						
50	0.03	0.045	0.06	0.075	0.09	0.105	0.12	0.15					
60	0.025	0.04—	0.05+	0.06	0.07	0.09	0.10	0.125	0.15				
80	0.02—	0.03	0.04	0.05	0.055	0.06	0.07	0.09	0.11	0.13	0.15		
100	0.015	0.02	0.03	0.04	0.045	0.05	0.06	0.075	0.09	0.105	0.12	0.135	0.15

Operating Cost

Table 3 shows how the cost of labor was determined, and is self-explanatory. The 10 per cent. added is to cover nonproductive time due to stopping and starting and incidental shutdowns.

The fuel was difficult to decide upon, but here as elsewhere, average conditions are taken. The boiler evaporation was taken at 6 to 1 and the losses between the boilers and the ice cans as 20 per cent. For nonproductive periods 10 per cent. was also added. The price of coal is taken at $3 per ton of 2000 lb. A change of 50c. per ton in the cost of fuel makes 11c. difference in the cost of the ice per ton.

Sundries is also an uncertain item, but the 8c. per ton has been found to check with practical results.

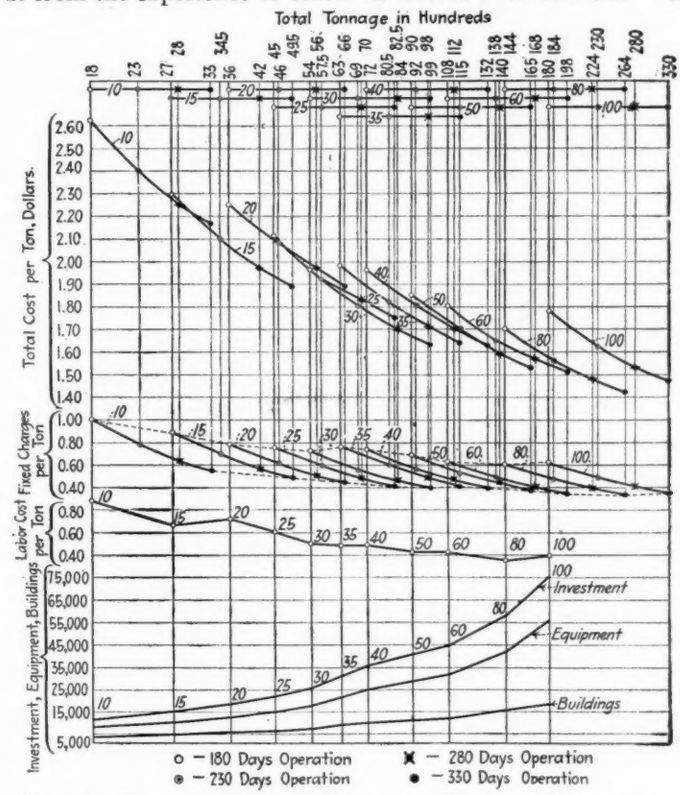
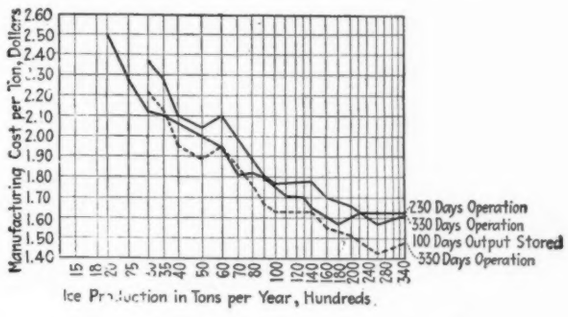


Fig. 1. Manufacturing Cost per Ton in Standard Distilled-Water Ice Plants


Manufacturing Cost per Ton, Dollars
230 Days Operation
330 Days Operation
100 Days Output Stored
330 Days Operation
Ice Production in Tons per Year, Hundreds

Total Cost of Ice per Ton

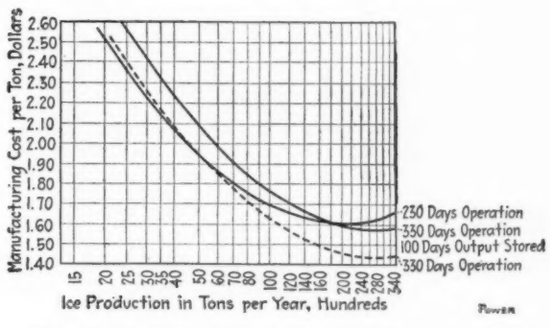

Manufacturing Cost per Ton, Dollars
230 Days Operation
330 Days Operation
100 Days Output Stored
330 Days Operation
Ice Production in Tons per Year, Hundreds

Fig. 3. Approximate Cost of Ice per Ton Deduced from Fig. 2.

Total Cost per Ton of Ice

Table 4 shows the cost per ton under the four periods of operation. Turning to the graphic record, Fig. 1, some interesting things are to be noticed. In the matter of fixed charges there is a group from the 20 to the 50 tons that shows a wide variation. This condition is also shown in the grouping of the plant productions as brought

out at the top of the chart, and clearly indicates that there are too many different sizes of plants to cover the range of production. If, now the 25-, 35- and 40-ton plants are eliminated, it is seen that the diagram would be more regular, and that the 20-, 30- and 50-ton plants cover the range even better than the intermediate sizes named. In the labor curve there is a pronounced rise at the 20-ton plant, but this is due more than anything else to the drop from the 10- to the 15-ton plant. If the 15-, 25- and 40-ton plants are omitted, the labor curve from the 20-ton on is decreasing, until the 80-ton is reached, where it is at a minimum, rising again toward the 100-ton plant. The total cost curves show that when all is considered the 80-ton plant is the most economical.

In the standard distilled-water plants under consideration, it is fair to assume that there is sufficient refrigerating capacity to care for an ice-storage house, and that the steam used for this purpose will not increase the boiler load. In the event that the house is located away from the plant, or has an individual refrigerating equipment, it will practically double the cost of storage as here given.

A properly built ice storage will be a substantial affair, and the depreciation will not be as heavy as on a manufacturing plant; 5 per cent. will cover this as well as the repairs. The initial cost may be taken as $5 per ton of storage capacity, and the size will be determined by allowing 50 cu.ft. per ton of ice stored. Where possible the dimensions should be such as to give a maximum content with a minimum of wall surface. For handling the ice, an allowance of 15c. per ton is made and to cover incidentals another 10c. per ton is added. Table 5 has been derived from the foregoing data in this way: The number of tons stored is taken at 50c. per ton, and this amount divided by the total tonnage for a 330-day period, as shown in Table 4, gives the amount that is to be added.

It will be noticed that this has been carried only to the point where the amount to be added in all cases is substantially 15c., which represents a storage period of 100 days' output.

From the cost of production, shown in Table 4, it is evident that anyone operating a plant full capacity for 230 days can, if they have sale for the ice, increase the capacity 43.5 per cent. with practically no change in the cost per ton, by using storage for 100 days' output and operating 330 days.

This statement, however, may be misleading, for this increased tonnage could be got with a larger plant in the 230-day period for less per ton. This is brought out in Figs. 2 and 3. This exemplifies what has already been stated that conditions must be studied and given due consideration in determining what is best in a particular case.

Often there are considerations such as varying demands at particular times of the year that will more than compensate for the extra charge of storing. These figures show, however, that the storage can be used to advantage in increasing the output where the plant is ordinarily shut down part of the time, and that there is not a great deal of difference in cost whether storage is used with the plant operating longer or a larger plant for a shorter period of time. On the other hand, the having of a supply of ice on hand may be the means of largely increasing the revenue and is therefore desirable.

Cost of Power for Ice Making

The writer was interested in attending some of the sessions of the Eastern Ice Association held Nov. 6 to 8 at the Park Avenue Hotel, New York City. Among other papers read was one by C. H. Stevens, of the Brooklyn Edison, in which he made an appeal for business for his company. By looking below the verbiage of the paper, the meaning was that his company would be glad to negotiate with any prospective users of electricity, and would be glad to furnish them current at the highest possible price that his salesman could extract from them.

In discussing the paper, he made the statement that one of the many reasons why the Edison Co. could produce current at a low figure, was because that company bought coal in great quantity. It was purchased at a price which he did not state, though intimated was approximately half what the ordinary user would have to pay. The coal people say that the Edison Co. pay within 5c. per ton of the price at which any purchaser can secure the same coal in the same vicinity. This small reduction would not make a noticeable difference in the cost of power per kilowatt-hour, and for that matter even if they got the coal for nothing the reduction in generating cost should not be more than 0.3c. per kw.-hr.

The question that was in the minds of all the listeners was—"At what price will you sell current?" This question the reader of the paper would not answer.

The practice of the central station is to charge anywhere from ½c. to as high as 15c. per kw.-hr. In almost every other business such as transportation, communication, etc., such discriminating rates have been shown to be illegal. Probably they will be so held in connection with light and power before long in many of the states.

In explanation and partly in excuse for such discriminatory rates, the central-station salesmen say, that owing to the peculiar peak loads that the stations have to meet, they can supply day current at a less rate than current used during the time of heaviest draft on the stations. This, no doubt, is a fact. At the same time it would be just as reasonable for the trolley companies and suburban railroad companies to insist that they should charge more for transportation during the rush period than they do during the nonrush hours.

The central stations have the pleasant habit of subsidizing the large users of current to the detriment of the small users—that is, they will make a contract with the large user of current at a low price, at a loss to themselves, perhaps, for the purpose of preventing the installation of an individual plant, and then make contracts with 50 helpless small users of current at a rate which is five or six times as much, which rate is, of course, exorbitant.

The whole question boils down to at what price can the ice maker buy current? If the central stations will contract to supply satisfactory current at 1c. per kw.-hr. for a term of years, it would be advisable to accept their proposition. If they will not do this it will pay the ice maker to investigate and find out exactly what an isolated plant can do in his individual case. When raw water is not used and it is necessary to distill the water, a boiler will do it, and an engine will not add much to the initial investment.

PAUL BIGELOW.

New York City.

EDITORIALS

Limit of Steam-Turbine Size

Ten years ago when the first five thousand-kilowatt turbine unit was installed at Fisk Street Station in Chicago it was regarded as a giant, not so much in actual size as in its enormous capacity. Engines of great bulk which approached the output of this turbine had been built, but for so compact a unit to deliver five thousand kilowatts and on an overload fifty per cent. more, was then considered remarkable. Since that time advancement in this field has been rapid. It was not long before the capacity of a single unit was doubled. Later the size was increased to fourteen thousand kilowatts, then to twenty thousand and almost simultaneously we hear of turbo-generators designed to deliver twenty-five thousand and thirty thousand kilowatts. The end is not yet, as an order has been placed for a jumbo turbine larger than any other by five thousand kilowatts.

There, of course, must be some limit to the capacity and consequently the physical proportions of a turbine unit, for, as expressed in *Engineering*, all prime movers are in the ultimate subject to the law that while the output increases as the square of the dimensions, the weights involved increase as the cube. For the present this consideration is not so likely to limit the size as the difficulty of transportation, the high cost of heavy castings and forgings, the heavy construction in the building and crane necessary to handle the unit in the plant and the proportions of the foundation. Then, again, there is the question of speed which, as the diameter of the rotor increases, with constructions of equal strength, must be reduced to keep down centrifugal stresses. To furnish three-phase currents at twenty-five cycles calls for a speed of seven hundred and fifty or fifteen hundred revolutions per minute. At the lower speed, which would be used with the larger rotors, it is the opinion of our contemporary that the practical limit of output is about twenty-five thousand kilowatts. Such a unit of the drum type arranged on the double-flow system would weigh from 250 to 300 tons and the heaviest part to be lifted between thirty and forty tons. The size of the forgings required would be about to the limit of what can now be obtained and the cost proportionally more than for castings of smaller size. Then in the larger casings distortions due to their own weight and variations in temperature are more pronounced, necessitating a larger clearance and probably reducing the efficiency.

Except perhaps in very special cases where there is an enormous station output, it would seem that a smaller unit, of say half the capacity, would give better all around satisfaction. It would then be feasible to employ the higher speed, fifteen hundred revolutions per minute, and as a result reduce the size and weight of the unit. The efficiency of a turbine depends largely on the ratio of blade to steam velocity, which, with given steam conditions, would vary as the product of the revolutions squared, the square of the mean diameter and the number of rows of blades. It is thus apparent that the volume and therefore the weight of the turbine casing, at fifteen hundred revolutions, is about one-fourth that required at seven hundred and fifty revolutions. The output per ton is greater, the floor space less and the efficiency higher. Incidentally the cost for castings per kilowatt of output would be considerably less and the difficulty of transportation obviated to some extent. Installing or dismantling the unit in the power house would be facilitated and the cost of the generator would be lower.

In the past duplication in the power plant has been considered desirable and in the early days necessary, due to the many breakdowns which were then common. Although not so necessary at the present time, it is still far from safe to put all or even half the eggs in one basket. In stations like Fisk Street or others of mammoth capacity the above reasoning would not apply. Here relative efficiencies and costs will determine the size of unit, but with present facilities and methods it would appear that the advantages from this standpoint also lie with the smaller unit. Of course, too great subdivision increases the total first cost, and the happy medium will be better determined after some of these great units have been in operation for a time and accurate data are available with which to draw a fair comparison.

Safety of Engine Governors

The danger attached to the operation of an engine with a rapidly revolving flywheel is rarely appreciated by the engineer in charge. He usually reasons that if the wheel is sound and furnished by a reputable builder there is no occasion to worry about its safety. Any flywheel can be exploded if rotated at a sufficiently high speed and like the explosion of a boiler from overpressure the stronger the material the worse the explosion.

Evidently the best safeguard against the explosion of a flywheel is careful attention to the devices which control the speed so that it will be kept below the danger point. All boilers used today in civilized communities for generating power have safety valves which are used for the sole purpose of limiting the steam pressures that may be carried. Steam engines are provided with governors to limit the speed and also to perform the function of admitting the proper amount of steam to maintain a uniform speed under varying loads. The purposes of safety valves and of governors therefore are not exactly parallel.

With the Corliss type of valve-gear it is customary to arrange safety cams so that the crab claws cannot move the steam-admission valves when the governor is in the lowest position. To start the engine, a block or equivalent device is provided to hold the governor in a position that will permit the admission of steam during the entire stroke. Blocking the governor in this way is almost the same as blocking the safety valve of a boiler while in the act of raising steam and though this may not interfere with the normal control of the engine while the governor is operative, yet, should any accident happen to the governor or its driving mechanism, a runaway

is quite sure to follow. No engineer can afford to take chances with his own life and reputation, to say nothing of his responsibility for the lives of those surrounding him, by operating an engine whose governor will not automatically move to a position of safety if its parts became deranged.

Governor-blocking devices are to be had that are arranged to automatically assume the safety position upon starting the engine and every engineer should see to it that his engine is properly equipped in this respect. With the purpose clearly in mind it is no extraordinary tax of mechanical ingenuity to devise and apply such a safeguard. A simple form is referred to on page 765. It might be still better if the engineer can persuade his employer to install an independent automatic engine stop and thus operate his engine with a device especially designed for safety as much as a safety valve for a boiler. In some plants using Corliss engines, it is essential that the machinery continue to move when an overload occurs and it is necessary to have the governor blocking in the danger position at all times. In such cases the installation of an independent automatic stop should be demanded by the engineer. It has been the experience of companies insuring against flywheel and boiler explosions that chances of serious accidents are greater from flywheels. In view of such experience no engineer can afford to be careless in regard to safety of the governing mechanism of his engine.

The Study Course

In this issue begins a new section of the Engineers' Study Course on the subject of Trigonometry which will be immediately followed by one on Elementary Mechanics. While logically these should have followed the division on Mathematics it was felt that it would relieve the monotony to interject an entire change of subject for a season, the better to hold the interest of the students—hence the section on Combustion, Evaporation and kindred boiler-room subjects concluded in the last issue.

Now that there has been this respite it seems appropriate to take up the study of trigonometry and elementary mechanics, and together, as the latter is so directly dependent upon the former. The student is advised to follow the next few lessons closely and to refer back to the earlier course in mathematics should he feel a review of it needful. Particularly to such as may not have followed the mathematics course it is urged that reference be made to it before going very far with the new subjects.

Vocational Training

How can the man in the operating field better his condition and advance in his vocation? How can he reach that coveted "room at the top"? He knows of its existence just as he knows there is a north and a south pole, but how can he fit himself for the journey?

Probably the plant owner's lack of interest and of cooperation has in great measure prevented the employee's advancement. Most plant owners appear utterly indifferent as to how economy is to be kept up and expense kept down; these little details are left to the engineer. How he does them is his business; but do them he must, or get out.

With a few notable exceptions, chiefly in the manufacturing field, the engineer's vocational training has usually depended upon what he could acquire by his own laborious efforts after a hard day's work, assisted, necessarily in a limited way, by his local and national associations.

In the power field, a few companies have helped their men to secure vocational training. From the boiler room have risen men by successive stages to positions of grave responsibility, and their employers have expressed themselves as amply compensated by the rich return in the service and the loyalty now rendered them.

"Power is a factor in all the important affairs of modern life," says a writer and thinker, and necessarily the engineer, who makes that power, is also a factor in that the whole purpose is not merely to "make the wheels go 'round," but to turn them at a profit. Furthermore, electricity, the steam turbine and the waterwheel have made the engineer's vocation even more difficult, demanding a degree of operating skill that is wellnigh impossible to acquire in some cases without special training.

We are told that of all the great nations, ours is the most deficient in vocational development. Germany forty years ago saw its need, and met it; England, Scotland, France, Austria, Switzerland, Norway, Sweden and Denmark are all paying heed to it. If we would successfully compete in our own chosen field with the large immigration yearly coming to our shores, we must find the means to equally educate our own people in their vocations.

Cleveland Municipal Rates

One of the chief arguments in the fight now being waged in many cities against rate discrimination and in favor of a general revision of central-station rates, is that no electrical energy should be sold at less than cost, all overhead charges considered. If this is to be applied to private corporations, there should be no exception in favor of municipally owned plants.

In the new rate schedule adopted by the city of Cleveland and printed on page 742, the price per kilowatt-hour ranges from a maximum of three to a minimum of one cent per kilowatt-hour on contracts averaging fifty kilowatt-hours or more per month.

When all the factors going to make up the total cost (generating, distribution, fixed and overhead charges) are considered, even with due allowance for sales in large quantities, it is inconceivable that the figure will come within the minimum rate of one cent per kilowatt-hour. Naturally with this attractive rate a number of contracts have already been closed and more will be entered into as soon as sufficient capacity is available. If the bulk of power is disposed of in this way; that is, to a relatively small number of large customers whose demand will entitle them to the minimum rate, it is obvious that the city will lose money and the taxpayers will be contributing toward the power bills of a few large concerns.

We realize that it is difficult to fix an equitable rate schedule and especially in advance of the completion of the plant, when a number of assumptions must necessarily be made. However, it would be interesting to ascertain the basis for the rates in question.

READERS WITH SOMETHING TO SAY

Orsat or CO_2 Recorder*

F. D. Harger in his letter of comment under the title of "Orsat or CO_2 Recorder," in POWER, Sept. 2 issue, overlooks one important fact. That is, when a man manages a plant, he should, wherever it is possible and consistent with efficient operation, keep the cost of producing power at a minimum. This is to his interest as well as to the interest of his employer. It is not only a question of a certain appliance being the means of reducing power cost, but rather will not some other apparatus, which costs less initially, do as well.

Recording instruments are naturally preferable to those of the nonrecording type, but in cases where a cheaper class of instrument answers the same purpose and where a continuous record is not necessary, it is a waste of money to purchase them. The tendency now is to analyze flue gases only as long as is necessary to determine the changes required to bring the boiler up to the highest possible efficiency obtainable under local conditions and then disregard the flue gases entirely except for an occasional checking up. Do with your boiler as you would with your engine. An indicator is used on an engine to locate trouble, and after adjustments are made that ends the use of the indicator for the time. Why should an expensive instrument be used continuously when it is unnecessary? I have noticed recorders where used are checked up with an orsat. Why?

Mr. Harger says he used an orsat to check up with. Would he have used it had it not been reliable? My original letter stated that the orsat was desirable first because it furnished as complete and reliable an analysis as was necessary and because of its low first cost and ease with which it could be handled.

A. POHLMAN.

Brooklyn, N. Y.

Jam Nuts†

Mr. Manning's criticism of your note on jam nuts is hardly warranted. He may have had the impression that the inside nut was to be regarded as only finger tight when the jam nut was set up, overlooking the supposition that the inside nut had already been set up solid.

In all practical work it is "necessary to obtain both the maximum draft before setting the jam nut and the position of the inside nut without backing it against the outside nut," in which your view is correct, and by your method you would not "displace the inside nut by the amount of lost motion," as Mr. Manning states, but only attempt to. This is what makes the jam nut effective. All nuts do not have lost motion as Mr. Manning states. Any good lathe hand can make a nut which has no lost motion, and which will never need a jam nut, even in the most severe service. But such a nut must be wrenched on all the way; it cannot be so loose as to be spun on with the fingers. Nuts that can be spun on 8 to 10 turns with one stroke of the hand are the ones that need jam nuts, and the jam nut must be set up good and solid so as to maintain a strain which will not allow the inside nut to be displaced by lost motion. When the inside nut is displaced by any amount of lost motion the jam nut then becomes worthless and may as well be omitted.

L. C. TUCKER.

Newburyport, Mass.

The Polar Planimeter on Circular Charts

Mr. Richardson's courteous comments, published in POWER of Oct. 21, upon my innocent and unobtrusive article which appeared in the Aug. 19 issue, remind me of the man who never uses a railroad train because they sometimes take people where they do not want to go. Rules and railroad trains must be used with judgment, but still used.

I maintain what I said in the original article that the polar planimeter may be used on circular charts to get approximate average values except in "extreme cases" of variation of the recorded quantity. I showed this by actually applying it to a chart in which the average variation was about 20 per cent., and from which the true value was a "little less" than that found by the planimeter. (Mr. Richardson misquotes me as stating that it checked.) I also showed by an example that a maximum variation of 40 per cent. with an average variation of 20 per cent. produced less than 1 per cent. of error. One can surely form an idea from these examples of the limit beyond which the variation may be considered extreme.

Mr. Richardson finds "it evident that the polar planimeter is only of sufficient accuracy when all of the autographic line lies on a narrowly confined portion of the chart." But he forms this conclusion by applying the planimeter to a chart in which the maximum variation is more than 200 per cent. of the average quantity, and the average variation is more than 100 per cent.; that is, he takes an extreme case of variation which in my article was clearly stated to be an exception to the rule. He then seeks to strengthen his conclusion by stating that if the rate (by the chart) had been "zero for the first 12 hr. and 2000 gal. for the next 12 hr., the error of the method would have been 26 per cent." (In his first example it was 7 per cent.) This is absolutely not so, because the diagram for the first 12 hr. would not and could not then be integrated since there would be no record for that time; and the result would be found from the second formula given in my article

$$\textit{Mean height} = \sqrt{\frac{\textit{area}}{3.14 \times F}}$$

in which F would be 0.5, corresponding to a semicircle. The average rate for 24 hr. would then be one-half that

*"Power," July 29, p. 176; Sept. 2, p. 344; Sept. 16, p. 406; Oct. 14, p. 545; Oct. 28, p. 613.

†"Power," Sept. 9, p. 375; Oct. 7, p. 515.

from the formula, and the error would be less than 7 per cent.

A slight modification of the method I proposed will enable the polar planimeter to give a result within 2 per cent. of error in such an extreme case of variation as that presented by Mr. Richardson. The chart should be divided into a number of time periods in which the variation of the record is not large; the mean height of each of these parts is obtained, using the above formula; and the whole of them averaged with regard to time for the result.

Admitting Mr. Richardson's assertion that there are many recording instruments used in which the record fluctuates widely from hour to hour, it is also true that there are many, if not more, in which the record is very uniform. This is especially the case when such instruments are used for testing, because the significance of test results depends upon uniformity. It follows that the polar planimeter is applicable, not only to rare cases, but numerous ones, with ample precision.

JULIAN C. SMALLWOOD.

Syracuse, N. Y.

Lubricating Engines in Cold Weather

In a manufacturing plant in a northern state there were two large engines in mills, located some distance apart which were so exposed that during cold weather it was almost impossible to get the oil to run through a ⅜-in. pipe to the engine bearings. The oiling system is of the gravity type with a tank located about 15 ft. above the engine. The engines were about 900 hp. each, and as there was much dust in the air a copious supply of oil was required to lubricate them. Sometimes the oil would congeal and stop running, and before it could be started again a bearing would start to heat. Each cylinder was supplied with a 4-qt. sight-feed oil pump, one of which was of such construction that a U-shaped piece of pipe was placed inside of it with the threaded ends extending through the top. One of the ends was connected to a ¼-in. steam line, and the other to a drip line. This kept the cylinder oil warm so that the pump would work in any kind of weather. The other lubricator had a glass body, and was of such construction that it was not possible to put a heating coil inside of it. But a coil was made by winding a length of ¼-in. pipe around a block of wood having a diameter of 2 in. larger than the diameter of the oil pump. There were about five full turns in the coil which was connected to the steam line, and also to a drip line. As this lubricator was more exposed than the other one, a box was made that would just slip over it and the coil to prevent radiation of the heat. That settled the cylinder-oil trouble, but then came the trouble with the engine oil. Each engine had an oil filter in which there was a steam coil in the bottom. Then a coil of ½-in. pipe was made and placed in the overhead tank to keep the oil supply in a fluid state, but in passing through the long, small pipe to the engine it would get thick, and, to prevent this a ⅜-in. steam pipe was laid alongside of and fastened to the oil pipe and covered with a 1-in. sectional pipe covering. This kept the oil warm as far as the oil cups, which were all taken off except those on the crank pins, these being taken apart and the body discarded, the pipe being connected directly to the bottom part containing the sight-feed. A ¼-in. valve was put in each line just above the sight-feed. On the crankpin the centrifugal oiler with its cup and stand was retained, the oil pipe being tapped into the top cover and a steam coil made to fit around the cup. The reason for this was to give a small reserve supply in case the oil in the pipes got too thick to run. Sometimes cylinder oil had to be used to keep the pin cool, which was done by shutting off the engine oil and putting cylinder oil in the cup. A steam and oil line was also run to the outboard bearing. Drip valves were placed on the ends of all branch steam lines, and a steam valve at the connection with the steam pipe. Both engines were piped up in about the same manner, each engine had an engineer who stopped and started, and did his own oiling when he had time, but before the system was changed it took two or three helpers to keep the oil warm.

After passing over the bearings the oil was collected in a tank below the engine-room floor and pumped by hand to the filter. After passing through the filter it was pumped into the overhead storage tank and used over again. There were two gallons of new oil put into the system every day, and as much was drawn out for lubricating machinery. The oil filter was cleaned monthly.

This system could have been connected to the exhaust pipe, and the oil heated by waste steam.

Hyattsville, Md. J. C. HAWKINS.

[Lubricating troubles of this kind are not uncommon in the North. When the weather is warm is the time to take steps to rearrange the system so that there will be no trouble and fussing about oil lines.

It is altogether too common practice to locate a gravity oil tank and filters on the engine-room wall or in some other place that is warm in summer but so cold in winter that the oil congeals so before reaching the engines that the supply at the bearings becomes inadequate.

Pumps or air tanks for elevating the oil are used with most gravity-oiling systems. It should, therefore, be possible in nearly every Northern plant to locate the gravity tanks over the boilers where it is usually quite warm. By putting the oil filters, receivers and pumps in an exhaust-steam heated room beneath the engine-room floor, the entire system could be kept warm. If some of the piping between the gravity tank and the engines is exposed to drafts, as is sometimes the case, besides covering the pipe, a small bypass line might be led around into the receivers. This would create a sufficient circulation of the oil to keep the system warm.—EDITOR.]

Excess Air and CO_2

Why are we continually afflicted and pestered with the CO_2 argument? We have been getting it heavily for some six or eight years. There is unceasing consideration of the evil effects of excess air, genuine calamity howling about it, varying with many admonitions that if the CO_2 is to be made right the necessity exists for admitting less or more air, etc. Why do we speak of excess air at all, why not substitute deficiency of coal? If the CO_2 is thought undesirably low and the draft is fixed let the fireman shovel coal on more rapidly and the rate of steaming will increase as will also the CO_2. If, as in a small plant, one or two men are doing the firing and an increase in the rate of shoveling and thereby the rate of steaming is inadmissible with increase of CO_2 as its pur-

pose, then obviously the draft cannot be considered fixed since every boiler has a damper and the occasion for using it is unmistakeably at hand. Restriction of it will reduce the flow of air and if the fireman keeps on with the same rate of shoveling as before the rate of steaming will be unchanged and the CO_2 will be raised. To connect the rate of steaming fundamentally with the rate of shoveling is correct. There is a minor effect of changing efficiency which may follow from change in the CO_2 content, but the effect is minor. In general, the rate of steaming follows the rate of shoveling, the talk about controlling the air supply being based on unmindfulness that the coal supply is basic and is in the hands of the man with the shovel, and, furthermore, that with dampers or blowers working with any given adjustment the rate of coal supply influences enormously the resistance of the bed of fuel to the flow of air through it, and accordingly the CO_2 content of the furnace gases.

H. L. H. Smith.

Brooklyn, N. Y.

Fastening Loose Babbitt in Bearing

While the methods of fastening loose babbitt to a bearing as told by Mr. Kopple and Mr. Hawkins in the Sept. 23 and Oct. 28 issues respectively are interesting, I think the following one is better because there is no danger of cutting the shaft with a broken holder screw:

By drilling ⅝-in. holes about ½ in. deep in the bearing cap or shell, and then enlarging the hole at the bottom, the babbitt will run into the holes and hold tight.

H. E. Smith.

Harrisburg, Penn.

[Drills for enlarging the bottom of a blind hole are available in the market.—Editor.]

Correction of Diagram

The indicator diagrams, Fig. 1, were obtained from the high-pressure cylinder of a 36x60x60-in. compound, Corliss, rolling-mill engine. The trouble with the head-end diagram was that the steam valve opened too early, that is, the head end had too much lead. On the return stroke the steam valve began to open slowly at about *A*, but the piston coming back with the steam valve open only a very little the steam was compressed to some pressure *B*, higher than boiler pressure before the steam began to flow back into the boiler. When pressure *B* was reached, the piston still coming back, instead of raising the pressure higher, sent the steam back to the boiler at practically constant pressure, which is indicated by the line *BG*. At *G* the end of the stroke, the piston coming to rest, the pressure dropped to boiler pressure and steam was admitted at this pressure until cutoff.

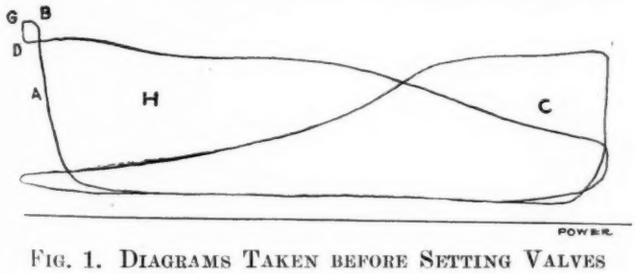


Fig. 1. Diagrams Taken before Setting Valves

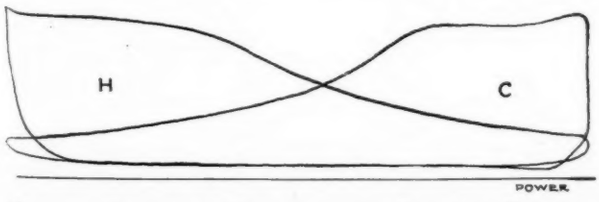


Fig. 2. Diagrams Taken after Setting Valves

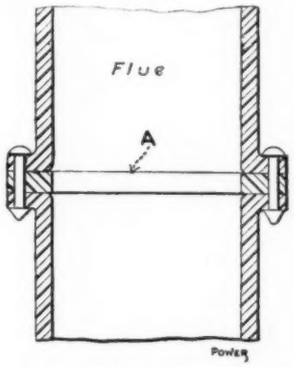
After taking off lead by lengthening the steam rod two turns, and adjusting the cutoff so as to divide the work equally, the diagrams shown in Fig. 2 were obtained.

J. F. Mowat.

Joliet, Ill.

The Adamson Ring

In the Massachusetts state law book on boilers, page 34, it tells of the "Adamson Ring" staying a furnace. Most engineers and fireman do not know about this ring or its use or where it is found.



Adamson Pipe-Joint Ring in Section

The Adamson ring is used on internally fired furnaces for staying of the flues; owing to the possibility of the flue collapsing, something must be used to stay it. The most common way to stay it is by means of a corrugated flue, the corrugations of which act as girder stays.

When the Adamson ring is used the flues are made in short lengths flanged at both ends. Between these flanges is placed a heavy piece of metal, shown at *A*, then the flanges are brought together, forming the Adamson ring.

This ring is not as reliable as the corrugated flue, owing to the possibility of leaking joints and failure of the rivets.

L. N. Webster.

Springfield, Mass.

Feed-Water Temperatures in Condensing Plants

It is common for operating engineers to desire the maximum feed-water temperature obtainable. The following is to show that in some cases a high average temperature for running hours is a source of loss instead of one of efficiency.

Taking the open type of feed-water heater the maximum temperature is, of course, 212 deg. F. If the load factor of the plant is high, such as during operating hours of pumping plants or flour mills, this high tem-

perature is desirable unless there is a loss of exhaust steam to the atmosphere. But take the plant with the low load factor, such as some lighting and railway plants. These plants usually obtain their exhaust for heating feed water from the auxiliaries. The use of auxiliaries does not decrease in proportion to the decrease in load; in other words, the use of steam by the auxiliary load represents a larger percentage of the total during "off peak" than it does during the "peak." So that if the maximum temperature is reached during the heavy load there must be a vast loss or excess of exhaust steam during the light-load periods. So the proper average for feed-water temperature depends upon load conditions and should be as high as possible with the minimum amount of loss of exhaust steam lost to the atmosphere.

Plants having an average feed-water temperature of 200 deg. F. or over should be watched for exhaust-steam losses, and if possible arrange the auxiliary units with the duplicates electrically driven for use during the light-load period. This serves to increase the operating-load factor as well as eliminating the wasteful steam-driven auxiliary where the exhaust is not needed.

JOHN F. HURST.

Louisville, Ky.

The Effect of Air in Feed Water

We had quite a discussion at our plant recently on the subject of open and closed heaters. There was one point touched upon that was new to me and may be of interest to others. One side claimed that an open heater was the best because it freed the water of air before it entered the boiler. The other side claimed that it was better to have the air pumped into the boiler with the water in the case of a noncondensing plant as the extra air made just that much more steam or working fluid without throwing any more work on the feed pump.

It appears that the air is not only compressed into the closed heater and boiler without any expenditure for power, but it requires no heat to evaporate it as it is already in the form of a gas. And this is not all. As the specific heat of air is about one-sixth that of water, it would require only one-sixth as much heat to raise the air to the working temperature.

Is this another "perpetual-motion" fallacy? If so, it is up to W. H. Booth and others to make the inevitable exposé before I begin selling "air-steam" engine stock.

FRED BOONE.

Davidson, Okla.

Cleaner Sticks in Boiler Tube

After thirteen years of experience with Stirling boilers we ran up against a "stunt" last Sunday that we never had occur before. The boiler, however, was not to blame for what happened.

We have four Stirling boilers, one of which is of 400-hp. capacity containing 88 tubes from the back drum to the mud drum. Last Sunday we undertook to run the rotary cleaner through these back tubes; a wire-wound, 1-in. hose is used with the cleaner and 70-lb. city water pressure applied. The rotary went through the first tube we tried, but in pulling it back, the wire became loosened from the hose and caught between the coupling of the rotary and the side of the tube, about 2 ft. from the bottom. The more we pulled the hose or drove it back the tighter we wedged in the rotary. The question was, how to get it out. We could not pull it up and the hose was not stiff enough to push it down.

After trying one thing and another for three or four hours, we went to the blacksmith shop and bent a piece of ¼-in. cold-rolled steel 3½ ft. long so as to form a hook with a turn like a cork screw. The screw was large enough to worm its way up by the cutters and around the legs of the rotary. This gave about 1½ in. of play up and down above the cutters. By forcing the hook down hard at the same time the men in the upper drum pushed down on the hose, we loosened the cleaner and drew it out from the bottom of the tube.

There was not wealth enough in North Adams to induce us to try to draw the rotary up through the tube with that hose so we cut the hose. It is needless to say that before that hose goes back in any tube again it will be thoroughly examined and the wire securely fastened.

JAMES MITCHELL.

North Adams, Mass.

Silencing Noisy Injectors

The articles* by Mr. Davies and others on suppressing vibration in power plants were instructive and interesting. These articles prompt me to inquire if any POWER reader has ever succeeded in silencing noisy injectors? Some of them roar and rattle so much as to unnerve even a boiler maker.

Will the man who has accomplished the silencing of an injector tell us how he did it.

H. D. FISHER.

Newton Highlands, Mass.

Cylinder Welded Successfully

The cylinder of a large engine in a near-by plant was badly broken by a slug of water. The top part of the head-end admission-valve chamber was broken across its entire length. A piece from the head end of the cylinder went with it, and the cylinder head and studs were badly strained and loosened.

There was immediate need for the engine and to wait until a new cylinder arrived would take too much time. It was, therefore, decided to send the parts to a welding company in the vicinity. This firm mended the cylinder by the acetylene process in short order and the engine is now working satisfactorily at the usual pressure of 150 lb.

Last spring I was called to examine an engine that "would not run" as the owner expressed it, and I found the cylinder cracked, due to freezing of water in the cylinder, the drain cocks of which had been left closed. This cylinder, although very badly cracked, was successfully welded in short notice by the acetylene process.

If new parts had been purchased in either of these cases the cost would have been more than double the cost of welding and the loss in time before the arrival of parts would represent a far greater sum.

A. I. HAIGHT.

Kalamazoo, Mich.

*"Power," Aug. 12, 1913, p. 247; Sept. 30, 1913, p. 481; Nov. 4, 1913, p. 653; Nov. 11, 1913, p. 700.

INQUIRIES OF GENERAL INTEREST

Setting of a Boiler—How much lower should a return-tubular boiler be set at the rear end?

A. N. O.

A boiler 16 or 18 ft. long should be set about 2 in. lower at the rear end to facilitate drainage toward the blowoff.

Boiler Manhole Reinforcement—What is the advantage of placing the reinforcement plate of a manhole inside of the boiler?

F. W.

By placing the liner or ring on the inside, the shell can be calked from the outside and the gasket joint made on a flat surface on the reinforcing ring.

Piston for a Rebored Cylinder—When a 14x20-in. engine cylinder has been rebored, making it ⅛ to $\frac{3}{16}$ in. larger in diameter, is it necessary to put in a larger piston as well as larger rings?

J. A. C.

The cylinder should receive a new piston or new adjustable bearing ring.

Hose Discharge—Will a hose discharge any more water if the nozzle is held horizontally than if held vertically, the pressure at the nozzle being the same?

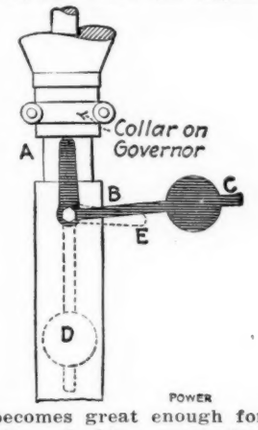
J. W. D.

A hose nozzle held perfectly vertical will not discharge as much water in a given time as if the nozzle is inclined a little to prevent the water falling back on the issuing stream; but a nozzle thus slightly inclined will discharge the same quantity of water as when held down or in any other position except vertically upward.

Automatic Governor Release—Is there any arrangement whereby the pin that blocks up the collar of a Corliss engine governor can be caused to drop out automatically when steam is turned on?

A. M.

A simple device used for supporting the collar of a governor in place of a pin, consists of a weighted bell crank, like the illustration herewith. After the engine has been started,



when the speed becomes great enough for the collar to be raised away from the end of the arm A, the weight of the arm BC throws the bell crank around to the dotted position DE, leaving the governor collar free to fall the same as by removing a pin.

Heating Air in Smoke Breeching—Four boilers, only three of which are run at a time, are connected to the stack by a horizontal breeching 40 ft. long, 3 ft. in diameter at the small end and 5 ft. diameter at the other. Would it be feasible to put, say a 16-in. pipe through this breeching lengthwise to heat air for drying purposes, the air to be drawn through the smaller pipe by an exhaust fan?

A. P.

A 16-in. diameter air pipe would reduce the draft area of the smoke flue about 20 per cent. at the smaller end, and about 7 per cent. at the larger end. If such a proportion of reduction in draft area would be permissible, the scheme might be tried. There would be a further reduction of the force of the chimney draft resulting from the reduction of its temperature, and the inner or air pipe becoming coated with soot, would require frequent cleaning or else would become very inefficient as an air heater.

Work of Gas Engine—Is the work done in a gas-engine cylinder entirely a consequence of the heat added by the burning of the gas in expanding the mixture, or is it partly due to a change of form of the gas, the new gas occupying more space at a given pressure, or exerting more pressure in a given volume?

H. R. C.

The first supposition is correct; in fact the burned mixture occupies less volume at the same pressure and temperature. This is in accordance with Avogadro's law that equal volumes of all gases under the same conditions of pressure and temperature contain the same number of molecules. For instance, take as a simple case the gases carbon monoxide (CO) and oxygen (O_2) burned to carbon dioxide (CO_2). The reaction is

$$2\ CO + O_2 = 2\ CO_2$$

This means that three molecules have become two and the volume has decreased one-third. The resulting CO_2 occupies the same space as the original CO so that the space occupied by the oxygen has been vacated. The work done in a gas engine is therefore due to expansion of the burned gases due to the heat added by the combustion.

Charging for Heat—One of two tenants in a building operates a power plant and heats with the exhaust steam. The other tenant wishes to purchase heat. How can a proper charge for the service be determined?

F. E. O.

Supplying the additional radiating surfaces will impose increased back pressure on the engine so it is fair to consider the extra steam as costing practically as much as if supplied direct from the boiler. For doing a given amount of heating the cost will be practically the same for supplying steam at one pressure as at another. The amount of steam required would depend on the weather exposure of the rooms to be heated, tightness of the doors and windows for exclusion of drafts, etc., and the temperature to be maintained. Under ordinary circumstances about 10,000 cu.ft. of space would require one horsepower of steam as an average for the season during which heating is required. Its cost taken as additional to the steam required by the engine would be about $3 per hp.-month for heating 10 hr. per working day.

The cubical contents of the premises to be heated; divided by 10,000 and multiplied by $3 will give the cost per month and to this should be added whatever seems appropriate as profit to cover trouble, investment, etc., to finally determine the total charge to be made per month.

Phenomenon of a Draining Vessel—Water flowing from any vessel through a bottom aperture begins a circular motion which increases in velocity as the water is nearly run out and an open space can be seen down through the center which increases in size as the amount of water becomes less. The same effect may be seen around the foot-valve in a pool. What causes this phenomenon?

J. W. D.

Water in flowing from any aperture which presents greater friction on one side than the other, will cause the issuing stream to assume a twist in the same way that the rifling of a gun, or two obstructions in a gun barrel not in line with the barrel, cause the shot to be rotated. In water, the whirling action set up in the discharge aperture is imparted back to the body of water which is presented to the aperture, and this tangential force continuing, increases the circular motion up to a velocity where it is balanced by friction. In an emptying vessel, the constant force being resisted by friction due to less pressure as the vessel empties, the whirling velocity increases, centrifugal force throwing the water out in the form of a funnel. Where the water over the suction into a foot valve is shallow, the centrifugal effect becomes greater than the pressure surrounding the foot-valve, and the effect is assisted by the depression of the water surface due to the discharge through the foot-valve being faster than the water can recover the general level of the surface of the pond.

ENGINEERS' STUDY COURSE

Trigonometry—I

The word *trigonometry* means triangular measure, or better, the measurement of triangles. Originally the object of the study was to solve triangles and that still constitutes the principal purpose of this branch of mathematics, although its scope has been broadened to embrace all investigations of the relations of certain ratios known as the functions of angles.

A triangle is a plain figure having three sides, the junctions of which form three angles. Two triangles are similar if their corresponding angles are equal, and identical if the corresponding sides are equal. If any three of

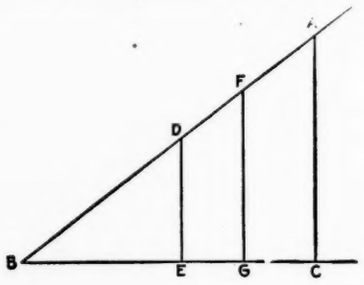


FIG. 1

the six parts—(the three angles and the three sides) of a triangle are known, and at least one of them is a side, the shape and size of the triangle are determined. A little thought will show that one could not construct other than identical triangles and make any one side and two angles alike, or any two sides and one angle alike or the three sides alike. Given, then, the numerical values of any three such parts, the unknown parts can be computed by trigonometry.

From the foregoing it is evident that there is an interdependence of the angles and sides of triangles. To study this interdependence trigonometry makes use of the right triangle.

In Fig. 1, ABC is an acute angle. If a number of parallel lines be drawn perpendicularly to BC, as DE, FG and AC, there will be formed a number of similar triangles, all having the angle ABC in common and the corresponding sides will be proportional. Suppose, for example, that BC has been made just twice as long as BE, it is quite apparent that BA is also twice as long as BD and AC twice as long as DE. Since these ratios hold it is also true that

$$\frac{BE}{BD} = \frac{BG}{BF} = \frac{BC}{BA} \text{ and } \frac{BE}{DE} = \frac{BG}{FG} = \frac{BC}{AC}$$

Suppose numerical values to be substituted for these lengths of sides, then each fraction (or ratio) would have a numerical value that would be the same for all right triangles having the same acute angle.

These ratios, of which there are six, are called *trigonometrical functions* and (with reference to the angle BAO, or angle A for short, Fig. 2) are given names as follows:

The ratio of the opposite side (a) to the hypothenuse (c) is called the *sine* of A (abbreviated—*sin* A).

The ratio of the adjacent side (b) to the hypothenuse (c) is called the *cosine* of A (abbreviated—*cos* A).

The ratio of the opposite side (a) to the adajcent side (b) is called the *tangent* of A (abbreviated—*tan* A).

The ratio of the hypothenuse (c) to the adjacent side (b) is called the *secant* of A (abbreviated—*sec* A).

The ratio of the hypothenuse (c) to the opposite side (a) is called the *cosecant* of A (abbreviated—*csc* A).

An easy way to remember these ratios or functions is to fix in the mind the picture of this triangle, Fig. 2, and memorize the following in connection with it:

$$Sin\ A = \frac{a}{c} \quad cos\ A = \frac{b}{c}$$

$$Tan\ A = \frac{a}{b} \quad cot\ A = \frac{b}{a}$$

$$Sec\ A = \frac{c}{b} \quad csc\ A = \frac{c}{a}$$

Functions Represented by Lines

Another and perhaps simpler way of remembering the functions is in connection with the diagram, Fig. 3, where the functions are represented by lines.

All of the ratios given in reference to Fig. 2 can be represented by lengths equal to the numerators if the denominators are made equal to one. For example, $sin\ A = \frac{a}{c}$ becomes $sin\ A = a$ if $c = 1$.

Let a circle be drawn with a radius equal to 1 and the

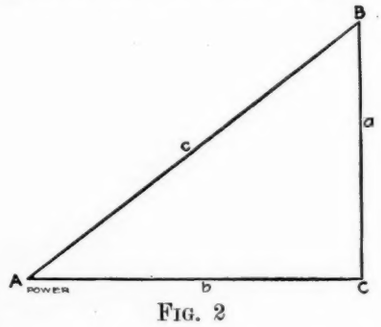


FIG. 2

angle A be laid off at its center, as in Fig. 3, AB (or c) is now equal to 1 and BC (or a) now represents by its length the sine of the angle A; then it may be so marked.

Similarly for $cos\ A = \frac{b}{c}$, if $c = 1$ $cos\ A = b$, or the line AC in Fig. 3. DB being equal to AC may also be taken to represent the cosine.

If, now, the tangent be considered, the triangle must be extended (but is still similar so that the ratios hold) until the side adjacent to the angle A (b) becomes 1 or equal to the radius of the foundation circle of the diagram, Fig. 3. Side b is now represented by the line AF and side a by the line EF which therefore represents by its length the tangent of A and may be so marked.

Let the triangle be still further extended until the side opposite the angle A (a) is equal to the radius of the foundation circle as at GH, and then $cot\ A = \frac{b}{a}$ becomes $cot\ A = b$, represented on the diagram by AH, or, what is the same thing, IG, which may be so marked.

For the $sec\ A = \frac{c}{b}$, b has already been made equal to 1 at AF so that the line representing the secant is already in the diagram, being AE and similarly for the $csc\ A = \frac{c}{a}$; when a equals 1, or GH, $c = AG$.

All of the foregoing functions which have been referred to as functions of angles are functions also of the corresponding arcs, since for every angle there is one arc, an arc being measured in degrees as is an angle. There are, in addition, two other functions which appear in the diagram, Fig. 3, but they have no part in the ratios existing in a triangle as indicated in Fig. 2. These other functions are known as the *versed sine* and the *versed cosine* or as they are more often called, the *versine* and the *coversine*. The versine is that part of the diameter intercepted between the extremity of the arc and the foot of

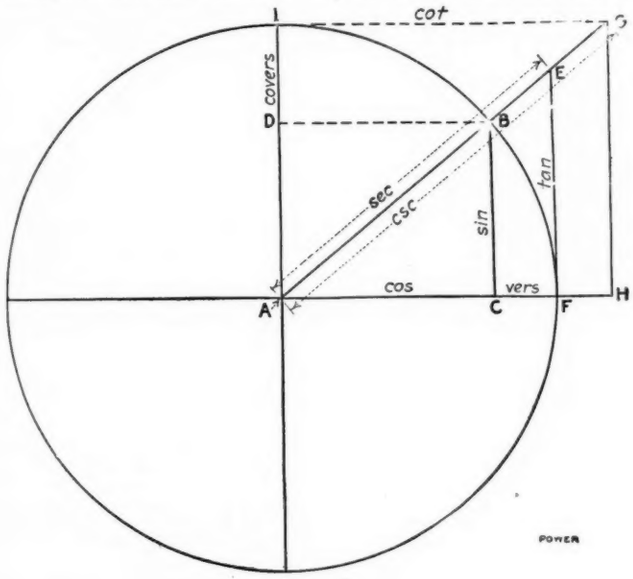


FIG. 3

the sine, shown by the line CF in Fig. 3. As the cosine and the versine added together make the radius

$$vers = 1 - cos$$

The coversine is shown at DI and added to the sign equals the radius so that

$$covers = 1 - sin$$

STUDY QUESTIONS

1. Find the values of the functions of angle A if a, b and c, Fig. 2, equal 3, 4 and 5 respectively.

2. If $a = 24$ and $b = 143$, what would be the $sin\ A$ and what would be the $cos\ B$?

3. The tangent of the angle of elevation of the sun being found to be 0.8 at a certain hour, what is the height of a chimney which at the same hour casts a shadow 160 ft. long?

4. In a right triangle the hypothenuse (c) is 240 ft., the $sin\ A = 0.6$ and $cos\ A = 0.8$; find the other two sides.

5. If $sin\ A = cos\ 2A$, what is the angle A?

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

"Here's the very note,
And this is what he wrote:"

"Dear Sirs Just a line to let you know to discontinue sending the power book as I dont think its an education book for I know more about engineneering than what the book can learn me so Therefore please stop sending it Obliging Mr Wm Woods Mineville N Y"

"Mr Wm" sure writes us a real polite note, and we are sorry we can't learn him nothing about "engineneering"— But judge, your honor we have other witnesses whose testimony will show that—

⁂

Now, here's a letter we'd cheerfully answer but it has no name or address:

"Dear Editor I would like to have the answer to the fowing No. 1 how ough a return tublur boilder be set. level or 3 inces lower at the back No. 2 how to found out what size punp is needes for a given H. P."

If this unknown seeker after knowledge will watch the "Inquiries of General Interest" page he will find out what he wants to know.

⁂

A St. Louis professor has announced a new law in physics. That's it, we are going clean crazy over the making of new laws. Why not stick to the old-fashioned physics of our boyhood, meaning to be duly respectful toward castor oil and such?

⁂

What chance has a ghost these days? asks "Collier's." An old Back Bay house was thought to be tenanted by "ghouls, ghosts, goblins, wraiths and banshees," until Prof. Schneider, of the Massachusetts Institute of Technology investigated—and then had a man mend a leaking gaspipe. Some psychology!

⁂

"What are the ten greatest inventions of our time?" asked the "Scientific American" recently. It awarded the prize to the contestant sending this list: The electric furnace, the steam turbine, the gasoline automobile, the moving pictures, the aëroplane, wireless telegraphy, the cyanide process, the induction motor, the linotype, the electric welding process. And all this was accomplished in a quarter century. Can you name offhand seven of the inventors?

⁂

The Panama-Pacific Exposition folks have planned a "temple of childhood" to exhibit little kids' pictures. What's its particular value? Of course, friend wife knows her "little Willie is just the prettiest, brightest little tike in all the world," but— Suppose she goes to this exposition and stands next to a big mutt who is saying: "Hey, Liz, pipe de kid wid de putty snoot; he's all mouth but de ears! D'ye git hep to de googoos?" You see, nobody will love Willie but mother. We reckon the temple of childhood is just home. Isn't it?

⁂

A THANKSGIVING PROCLAMATION

Thursday's Thanksgiving Day, Bill! Let's be thankful—thankful that we have a job; that our folks are free of sickness, and of sorrow, and of want; that on occasion we can still scare up a hearty laugh and a cheery smile; that our Ethelbert can lick any other kid on the block; that Edythe and her Adelbert are soon to be made one—and we'll have the "front room" to ourselves. Being thankful is a "thank-you" job, but it pays.

And say, Bill, mebbe our missis, 'way down deep in her heart, is thankful that we are fairly decent fellers as husbands go these days—that's a whole lot to be thankful for, son.

There are mean spots aplenty on the knotty old face of Mother Earth—and perhaps there are folks who think you and me, Bill, are contributing a bit to 'em. Reckon we do feel and act kind of mean and ornery on our off days, we're just plain, run-of-mine chaps at our best. But we're going to do better, and we're trying, ain't we, Bill?

So—let's buck up, you and me, and be thankful!

Effect of Peak Load on Boiler Operation*

SYNOPSIS—The economy of handling peak loads by forcing the boilers to 200 per cent. or more of their rating. Incident to this, greater attention should be paid to the feed water.

❖

The handling of peak loads in power stations supplying service to railway or lighting systems is a matter of daily operation. In addition to the daily load changes there is a peak due to the seasonal changes of traffic or lighting requirements that fixes the maximum demand to which the plant equipment must be proportioned.

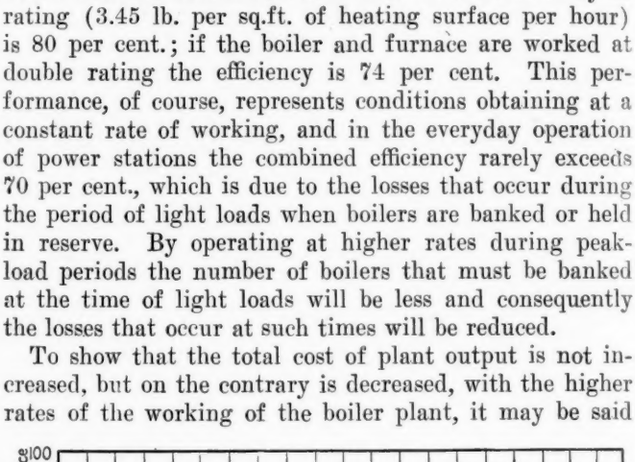
There has long been prejudice against what has been termed the "forcing" of boilers and all kinds of dire consequences have been predicted in addition to exaggerated statements as to the loss in boiler efficiency by such practice. There is, however, a gradual breaking away from these ideas, particularly in the larger and more modern stations.

Approximately one-fifth of the total heat supplied by the furnace, when operating at 200 lb. pressure, is represented in raising the temperature of the feed water from 200 deg. F., to steam temperature. The full opening of the valve may deliver water to the boiler at a rate of five or ten times the normal rate of evaporation. Thus if the feed valve remains open for any considerable time the total heat input from the furnace may be spent in raising the temperature of the water and at this time the output of the boiler is reduced to practically nothing. These features of feed-water regulation are now better understood, with the result that regulators are now available which give a graduated control of the feed water and permit a variation in the water level between any two extremes that may be fixed. The height of the water in the gage-glass, when the water level remains constant, is then some indication of the rate at which the boiler is being worked. This method of feed control enables peak loads of short duration to be carried with a more uniform working of the furnace, as sudden demands for steam will cause a fall in the water level without a corresponding increase in the rate of feed. The value of the graduated control of the feed-water supply will be appreciated when it is remembered that the water contained in the drums of an ordinary 500-hp., water-tube boiler is sufficient to supply full rated capacity for five minutes with a fall in water level of only one inch without other feed supply.

Curves, showing the combined efficiency of boiler and furnace when operating at various rates of evaporation (from and at 212 deg. F.) per sq.ft. of heating surface, are herewith shown. It will be noted that the stoker-fired water-tube boiler is operated to about 10 lb. of water per sq.ft. of heating surface (from and at 212 deg. F.), the oil-fired marine boiler to about 19 lb., and the hand-fired locomotive boiler to slightly over 20.

The usual rating of boilers in stationary service is 10 sq.ft. per b.hp., which is equivalent to the evaporation of 3.45 lb. (from and at 212 deg. F.) per sq.ft. of heating surface per hour. By reference to the curve, it will be noted that the combined boiler and furnace efficiency at rating (3.45 lb. per sq.ft. of heating surface per hour) is 80 per cent.; if the boiler and furnace are worked at double rating the efficiency is 74 per cent. This performance, of course, represents conditions obtaining at a constant rate of working, and in the everyday operation of power stations the combined efficiency rarely exceeds 70 per cent., which is due to the losses that occur during the period of light loads when boilers are banked or held in reserve. By operating at higher rates during peak-load periods the number of boilers that must be banked at the time of light loads will be less and consequently the losses that occur at such times will be reduced.

To show that the total cost of plant output is not increased, but on the contrary is decreased, with the higher rates of the working of the boiler plant, it may be said


Per Cent. Combined Efficiency, Boiler and Furnace
100
90
80
70
60
50
40
Marine Boiler Oil Fired
Water Tube Boiler Stoker Fired
Locomotive Boiler Hand Fired
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Equivalent Evaporation (from and at 212° F.) per Sq. Ft. Heating Surface
Power

COMBINED EFFICIENCY FOR DIFFERENT RATES OF EVAPORATION

that the boiler-room portion of the ordinary power plant costs about $30 per kw. when boilers are installed on the basis of operation at rated capacity. The cost can be reduced to nearly half this amount if the boilers are installed to operate at double rating during the peak-load periods, thus reducing the first cost of the plant by, say, $12 per kw. The saving in fixed charges on this amount, at 12 per cent. per annum, would, therefore, amount to $1.44 per year on each kilowatt of installed capacity. Taking the yearly load factor at 27.5 per cent., which corresponds to an annual output of about 2500 kw.-hr. per kilowatt of installed capacity, the saving in fixed charges becomes 0.58 mil per kw.-hr. The coal consumption per kilowatt-hour of the plant will be increased in an inverse proportion to the boiler efficiency at the two rates of working and there will be required, if the plant is worked at double rating during peak loads, $^{80}/_{74}$ of the coal at normal rating. Such a plant would operate at 2 lb. of coal per kw.-hr. under normal operation, requiring, therefore, 5000 lb. of coal per year per kilowatt of installed capacity, which at $2.50 per net ton amounts to $6.25 per year. The annual cost for fuel at the higher rate of operation would, therefore, be $^{80}/_{74}$ of $6.50 or $6.75, an increase of 50c. per kilowatt of installed capacity per year for fuel. The net gain at the higher rate of working would, therefore, be nearly $1 per year per kw. of plant capacity. The gain under actual operating conditions would no doubt be greater, because the differ-

*From a report by B. F. Wood, of the Committee on Power Generation, American Electric Railway Engineering Association.

ence in the combined efficiency of boiler and furnace, under the average rate of working, would not be as great as the difference at the maximum rate of working as taken above. It is evident, therefore, that lower total costs may be obtained by operating the boilers at higher rates of evaporation during the peak-load periods.

It is necessary to give greater attention to the condition of the boiler-feed water, where the boilers are to be operated at high steaming rates as injury to the tubes is more likely to occur under this condition, particularly if the water contains scale-making matter. This, of course, is of less importance where surface condensers are used and the percentage of makeup water is small, but in plants where jet condensers are used it may be necessary to provide for treatment of the feed water. The usual method of treatment is by caustic soda or soda ash, added while the water is hot, preferably at about 200 deg. F. After this treatment, and before the water is fed into the boilers, dry soluble tannin extract may be introduced which will keep the scale-making matter in solution. The cost for chemicals for this treatment is from one to two cents per 1000 gal. and gives as good results as can be obtained, except by evaporation.

There is a process of water purification by evaporation being tried out at the present time, where the heat is supplied by compressing the vapor by a positive blower to about 1 lb. above atmospheric pressure. It is stated that this system will evaporate about 100 gal. per kw.-hr. and if current for the operation is taken during the off-peak hours it may be furnished at the actual cost of the fuel.

In plants that are to be worked at high rates of evaporation it is important to select only those types of boilers which are free from stresses, due to temperature changes, and which permit of easy renewal of tubes. When boilers are to be worked during peak-load periods at from 7 to 10 lb. of water per sq.ft. of heating surface, that is, from two to three times the rated capacity, the total cost of the boiler plant will be so greatly reduced that the very best boiler structure for the purpose can be selected without greatly increasing the cost of the plant. The cross-drum type of boiler offers advantages for high rates of working as the discharge from the upward circulation of steam and water is near the center of the cross drum and therefore near the normal water level, thus liberating the steam near the surface of the water which permits of freer and more rapid circulation. It is this type of boiler that is designated as the marine boiler on the curve showing the very high performance and high economy.

❋

The Value of the Engineer

By Dwight B. Pangburn

In the following is an example of how the engineer can make himself more valuable—both to his employer and himself.

A certain factory in New England has a power plant containing five return-tubular boilers aggregating about 400 boiler hp., supplying a 100-hp. Corliss engine, a 100-ton refrigerating machine (compressor), a direct-connected, direct-current generating unit of 75 kw. (the prime mover being a horizontal compound engine), a triplex pump of 2,000,000 gal. per 24 hr. capacity, belt driven from a vertical simple engine, and various other smaller steam pumps. The product has to be both heated and cooled in process of manufacture. This requires steam for heating and refrigerating plant for cooling. The engineer has charge of both the operating and repair departments, and is also called on to superintend his men in doing any installation work necessary in the plant.

A little before the end of 1907 the chief engineer left to take a better position and a new engineer was employed. The first thing the new man was told was that the one who had preceded him was a pretty fine engineer, and that if he could keep things running as well as they were when he took the job the company would ask nothing further from him. Whether this was said because the officials believed it or not, it very naturally had the effect of starting the new man to look for every chance he could find to make improvements. He was given his predecessor's last year's record as a model and did not learn for some time that it was 20 per cent. better than the man's average for all the time he had been on the job.

The first thing that caught the new man's eye was that the firemen were not firing well. They were leaving holes in the fires all the time and were sloppy in many ways. He also saw that the firemen were working in two shifts of 12 hr. each. He reasoned that no one could expect consistently good firing from men throwing coal for 12 hr. a day, seven days a week, so he immediately cut the hours from 12 to 9 per day, giving the men one day off in two weeks, and giving them the same amount of pay per week. He also installed a recording pressure gage where the firemen could see it and at the same time requested them to fire a little better—there has not been a hole in the fires since, and the cards from the gage are very good.

There had also been, formerly, two watch engineers, on two 12-hr. shifts and working 365 days a year. Considering that what was fair for the firemen was fair for the engineers, he added another watch engineer and made three 8-hr. shifts, thus also allowing the men two Sundays off out of every three.

Not content with thus assisting the operating force to make a better record, he made another valuable change. The layout of the plant makes it necessary to have the coal dumped in the yard, being wheeled from the coal pile into the boiler room in wheelbarrows by hand. The boiler-room floor was of earth. The firemen frequently dug up sections of the floor and threw it into the furnaces along with the coal. This made it bad for all concerned so the engineer had a smooth concrete floor laid in the boiler room and a walk out to the coal pile, so that the coal could not only be easily wheeled in from the coal pile, but could also be easily shoveled up from the floor.

In addition to these radical changes he began buying coal that cost 50c. more per ton, proving by analyzing it that he was getting more heat units per dollar.

All these changes came in the year of 1908, yet by looking at the appended table it will be seen that the saving was sufficient to more than pay for the increased wages and other expenses, as the operating costs were 1.1c. less per unit of manufacture than in the preceding year, this being about 5 per cent. less cost while 7 per cent. more work was turned out of the shop. During the month when the best showing was made, when 10,100

units of manufacture were turned out, 521 tons of coal were saved, as compared with the corresponding period during the preceding year, when the amount of work done was almost identical.

The new engineer soon found why his predecessor's last year had been the least expensive. It was because he had left all the work he could for the new man to take care of. Among other things there was hardly a tight valve in the whole plant, even on the ammonia lines. A valve-seating machine was purchased and as many men as could be spared were set at work on the piping. In time the valves were all fixed and the leaks in the piping taken care of, often by putting in whole new lines of pipe. This work was hindered by having at this time to devote half the force to the work of installing automatic sprinklers in a large part of the works, the men's pay still being charged against the operating department, while they were doing this work. While in the piping business, and going on the idea that each 6 sq.ft. of exposed steam piping will eat up one ton of coal per year, half a carload of pipe covering was put on, and so the coal pile was again conserved.

After the company was induced to buy the operating department an indicator, something never considered worth while before, the engine valves were shown to be out of adjustment and the rings leaking badly. By fixing these two difficulties the amount of steam used for power was cut down about 20 per cent., which soon paid for the indicator.

Still the new engineer thought that the saving was not enough. He was having the boilers cleaned regularly, and oftener than ever before but he thought they needed further attention. He secured a $25 flue-gas apparatus and tested his flue gas. To his surprise he found only 3.5 to 4 per cent. of CO_2, showing that two or three times as much air was being supplied as should be. He had already plugged and cemented up numerous holes in the boiler settings, and decided the trouble must be in the hollow walls between adjacent boilers. (The boilers were in one battery of three and one of two.) These walls seemed in good condition, but he investigated more carefully, rebuilt the walls entirely and the flue gas showed 10 to 12 per cent. of CO_2 while the draft was also much improved. This fault might not have been discovered for a long time without the flue-gas tester, and thus a $25 instrument and a little care saved a lot of money.

As before stated, steam is used in one part of the works in the heating coils in boiling retorts. The boiling is accomplished at a vacuum of 15 in. or more, maintained by a barometric condenser. Live steam from the boilers was being used for the boiling, coming at 60 lb. gage pressure to a valve at the side of the retort where the quantity and consequently the pressure, were controlled. After pointing out that steam at 60 lb. had only a temperature of 310 deg. F. while at 4 lb. it had 225 deg. F., and that the total heat available in a pound of steam at the two pressures did not differ by more than 25 or 30 heat units, he obtained permission from the superintendent to try using exhaust steam instead of live steam. The superintendent feared it would cut down his production, but since exhaust steam was first run through the heating coils, no live steam has entered them, not even in winter.

The engineer had discovered that the back pressure on the engines was about 5 lb., because the main exhaust was too small and had nearly a dozen right-angle turns in it. Now the exhaust steam is run direct to the boiling retorts and from them through a large feed-water heater to a barometric condenser. As a result the engines exhaust against from 3 to 4 lb. back pressure, or less, the exhaust passes through the boiling coils and then heats the boiler feed and goes on to the condenser. The water used in the condenser to condense the steam comes down through the feed-water heater and then through a home-made economizer made of pipes running through the uptake of the boilers, and so is finally pumped into the boilers, usually at a temperature of 180 to 200 deg. F. While the retort coils had to be bypassed and a new and larger feed-water heater put in, the saving soon paid for the expense.

Naturally all these changes did not occur at once. The chief has only a few men to work for him and the operations described take time. The work mentioned was most of it done, however, during 1908-9-10. More improvements are going on, and all could have been done in less time were it not that the officers of the company were, in the beginning, somewhat slow to give the engineer a free hand, and he had to fight for whatever he got. Now they have got to where they swear by the engineer instead of at him, and it shows nicely on his pay check, too.

The appended table shows at a glance the results of this engineer's crusade against incompetency, carelessness, and the overloading of labor. 1907 shows the last year of the first engineer. It is 20 per cent. better than his average. The tables are based on the unit of manufacture, which has remained the same.

The first line shows the number of units of manufacture turned out during each year.

The second line, giving coal in tons per unit, shows how the boiler-room economy is helped by buying good coal and firing it well. The third line, giving coal per unit in dollars, shows the financial result of such action, the cost of coal ranging from 17.8 to 22.3 per cent. less than in 1907.

The fourth line gives operating cost per unit in dollars. This includes the cost of coal, labor and supplies. It is higher for 1909 and 1910 than in 1907, but the result of better quality labor is shown in the reduced repair bills.

Line five shows that the repairs per unit have grown steadily smaller, due to the better labor and better arrangement of the plant.

In the seventh line is shown the percentage of improvement, figured on 1907 as a basis. While the greatest improvement financially is 19.1 per cent. (in 1911) the service which the whole factory gets from the engineering department is admitted to be 50 to 100 per cent. more satisfactory. This is because the men in the department, being contented, pull together instead of apart.

The sixth line gives the total cost per unit of the engineering department, this being the sum of the operating and repair charges. It may be summed up by saying that where the old engineer turned out one unit with dissatisfied, inefficient, underpaid and overworked labor, and a plant that was falling to pieces, for 49.3c.; the new man, after three years of constructive effort, was turning out the same unit with higher-paid, satisfied, efficient engineers, firemen, etc., and with a plant that is in fine

condition and worth much more than when he began, all for 39.9c., or 80 per cent. as much as formerly—and he is still doing it.

This is an actual instance of engineering efficiency in which the saving in money amounted to thousands of dollars while the human saving was also enormous. What it means to workmen is this: Earn more for your employer and you will earn more for yourselves. What it means to employers is; hire good men and pay them enough to keep them satisfied. Both will profit as a result of such action.

TABLE

Year	1907	1908	1909	1910	1911
Units manufactured	130,581	139,593	109,612	100,200	127,201
Coal per unit, tons	0.386	0.299	0.349	0.342	0.314
Coal per unit, dollars	0.130	0.101	0.107	0.106	0.103
Operating cost per unit, including coal, dollars	0.207	0.196	0.218	0.216	0.196
Repairs per unit, dollars	0.286	0.267	0.265	0.219	0.203
Total, engineering dept., dollars	0.493	0.463	0.483	0.435	0.399
Percentage of improvement	0	6.08	2.03	11.76	19.07

Lytton Vacuum and Lifting Trap

This trap has been designed to automatically remove condensation from any apparatus under low steam pressure or any vacuum obtainable, and lifting the water to any desired point. With a 12-in. head the trap will work up to its normal capacity, which is increased with more head.

The trap is simple in construction, consisting of a cylindrical body held in place between two heads, by through bolts. The bottom head contains a tee which

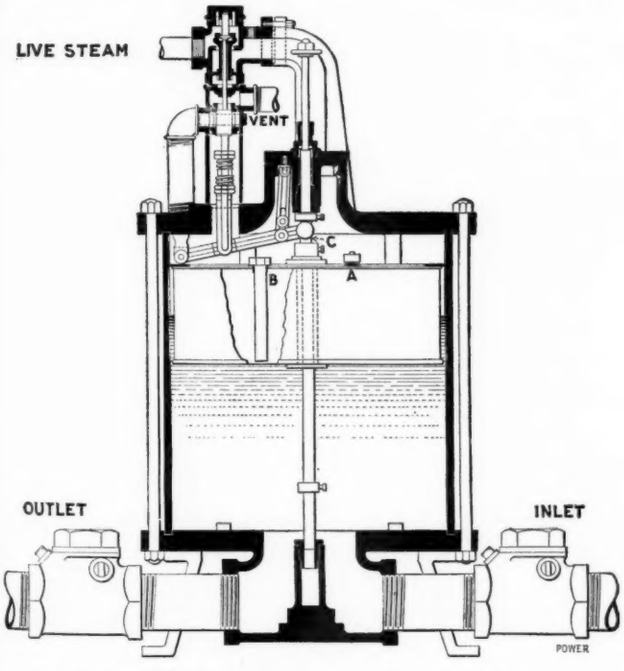


FIG. 1. SECTION THROUGH VACUUM TRAP

serves as an inlet and discharge, the connecting pipes being fitted with horizontal swing check valves.

On the inside of the trap there is a floating piston which operates a regular return steam-trap valve, placed on the outside of the trap. The top of the floating piston is provided with a steam-inlet valve *A*, Fig. 1, and a vacuum valve *B*. A tappet spindle *C* passes through a hollow center of the floating piston. As the trap fills with water the piston rises until the tappet is reached when any further lifting of the piston raises the lever which is attached to the valve stem of the steam and vent valves. This movement opens the steam valve and admits steam to the body of the trap, forcing the water out through the outlet pipe. At the same time steam is admitted to the interior of the floating piston through the valve *A*,

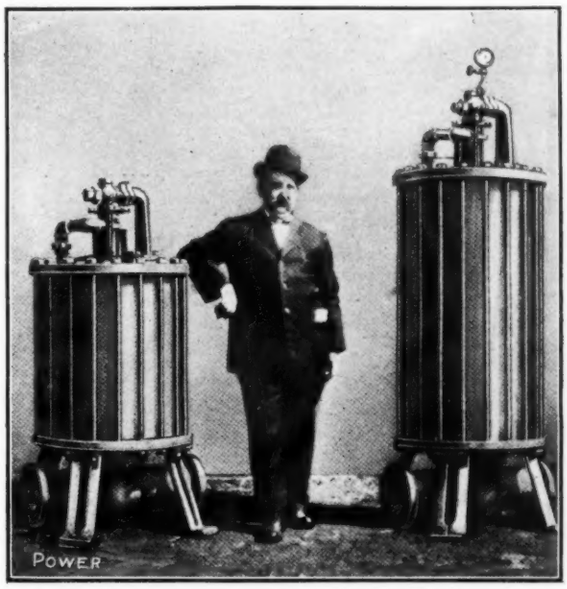


FIG. 2. TWO 6-IN. VACUUM TRAPS

which equalizes the pressure on the inside and outside of the piston.

When the trap has emptied, the floating piston drops until the lower tappet is reached when the tappet rod is forced downward, which movement closes the steam-inlet valve and opens the vent, thus admitting atmospheric pressure to the trap. The valve *B* permits of breaking any vacuum that might have formed within the floating piston from condensation of the steam admitted through the valve *A*.

There are several salient points of interest in the design of the trap, which is manufactured by the Lytton Manufacturing Corporation, sales office, 50 Church St., New York City. It requires but very little floor space, as illustrated by Fig. 2. The trap shown at the right is a photograph of the largest trap in the world. It has a capacity of 1000 lb. of water per minute at its normal rate of discharge and 1500 lb. with a maximum discharge. The small trap is of standard size with a capacity of 400 lb. of water per min.; maximum discharge 600 lb. per min. Both traps are 30 in. in diameter. The large one is 80 in. high, the small one is 54 in. high. Both have 6-in. inlet and outlet connections.

The trap will handle liquids at any temperature from 40 deg. up and can be used in connection with a dry-vacuum pump to drain surface condensers. As it does not churn the water, it is valuable in ice plants, as clean condensation will be had even if a small quantity of pure oil is handled with the water.

Cooling Generating Windings—To aid in cooling generators on overload, Sydney F. Walker, in the "Electrical Review and Western Electrician," for Nov. 15, proposes to refrigerate the air and thus obtain a greater temperature range in its passage through the generator windings. His plan is to use the wet-filter process of cleaning and cooling the air, but instead of a water spray, to substitute brine from a refrigerating system.

Purchasing Agents Form Association

The formation of the National Association of Purchasing Agents was consummated at the Hotel McAlpin, Thursday evening, Oct. 16. Headquarters will be in New York City. Over 100 purchasing agents and buyers, representing large industrial corporations, railroads, steamship lines, street railways, gas and electric companies in New York, New Jersey and Connecticut are now members, and many others intend joining toward the end of November.

H. T. Leeming, of Thomas A. Edison, Inc., was elected temporary chairman, and Elwood B. Hendricks, the organizer, was elected temporary secretary and treasurer. Mr. Hendricks is well known to purchasing agents, having been connected with "Hendricks Commercial Register" for a number of years, and is a son of S. E. Hendricks, president of the Hendricks-Sullivan Corporation. Temporary headquarters are at the Hotel McAlpin, 34th St. and Broadway.

This association will be devoted entirely to the interest of purchasing agents and buyers, and will have subassociations in all sections of the country. Some of the objects are forming the purchasing agents and buyers into a national body; the standardization of purchasing routine and methods; investigating new appliances and materials; improving methods for diffusing market information; gathering and disseminating data on buying; standardizing specifications, and other features of benefit to the agent or buyer.

The active campaign will be inaugurated after the next meeting in all the principal commercial centers for the securing of new members. Purchasing agents and buyers are invited to communicate with E. B. Hendricks, P. O. Box 1406, New York City.

Modern Science Club's Activities

The winter's activities of educational and social work at the Modern Science Club of Brooklyn are now in full swing. The educational committee will hold one lecture each month, on the third Tuesday evening. It was thought that in this way those who wished to attend these lectures would have a better opportunity of being present, as many of the members are interested in other engineering associations; it also insures a much larger attendance and more interest.

For Tuesday evening, Nov. 18, the lecture will be on the preservation and manufacture of metals for boilers, by W. P. Wilkinson, supervising engineer of the Perolin Co. On Dec. 16, W. W. Montabro, of the Harrison Safety Boiler Works, will talk on the hot-water meter. The clubhouse is conveniently located at 125 South Elliott Place, Brooklyn, about two minutes' walk from the terminus of the subway, at Atlantic Ave.

Engineers and others interested in steam engineering in Greater New York are always welcome at the clubhouse, which is admirably fitted up and adapted for the purposes of an engineers' club. It contains parlors, two large meeting rooms, billiard room and cafe, and is now the headquarters of several operating engineers' organizations in Greater New York, including N. A. S. E. organizations and the United Craftsmen's Council of Engineers. It is also the headquarters of the Brooklyn branch of the Ladies' Auxiliary of the N. A. S. E.

On each Tuesday evening a general social meeting with entertainment is held, except on the third Tuesday of each month, when a special lecture program is provided.

The officers of the club are: President, John P. Bonney, of the Thompson, Bonney Co., electrical manufacturer and contractor; vice-president, James R. Coe, president, National Association of Stationary Engineers; secretary, John P. Martin, chief engineer, College of the City of New York; financial secretary, James W. Starrett, chief engineer, Manhattan Brass Works, New York; treasurer, George O. Kaley, chief engineer, Naval Y. M. C. A., Brooklyn, N. Y. The directors of the club include many men who are interested in steam-engineering work.

The club is in a very prosperous condition and invites all people interested in steam engineering in Greater New York to come to the clubhouse and make it their headquarters. A warm welcome is assured.

Westinghouse Machine Co. Extends Facilities

At a recent meeting of the executive committee of the Westinghouse Machine Co., $125,000 was appropriated to provide additional manufacturing facilities.

This equipment is required to take care of the company's increasing business, owing in a large measure to the new lines of products developed, particularly the impulse turbine, the reduction gear, which in addition to the demand for marine installation, is finding wide application in connection with the large direct-current generators. The gear is interposed between the high speed of the turbine and the low speed of the direct-current machine with its commutator.

The company contemplates devoting a portion of the appropriation to securing additional machine tools designed to use high-speed tool steel, fully realizing their advantages, and thus adding to the already well equipped shop which this company now has in operation.

SOCIETY NOTES

The fourth annual convention of the Practical Refrigerating Engineers' Association will be held at Dallas, Texas, on Dec. 11, 12 and 13, at the Hotel Adolphus.

The sixth annual meeting of the National Gas Engine Association will be held at Toledo, Ohio, at the Boody House on Dec. 4, 5 and 6. An interesting program has been prepared; some of the papers will appear in abstract in an early issue.

PERSONALS

M. G. Doll has taken the position of general sales manager with the Bury Compressor Co., Erie, Penn.

Leo G. Smith, who has been superintendent of the open-hearth works of the Prime Steel Co., Milwaukee, Wis., for the past two years, has been appointed works manager of that plant and also of the company's crucible plant.

Heinrich J. Freyn, formerly consulting engineer of the gas-engine department of the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has recently joined the H. Coppers Co., Chicago, Ill., in the capacity of third vice-president.

Otto Wartenweiler, formerly in charge of the mechanical design and construction of a 400-ton milling and cyaniding plant for the Commonwealth Mining & Milling Co., has opened an office in the Van Nuys Building, Los Angeles, Calif. He will be the manager for Otto Wartenweiler & Co., engineers and contractors.

Frank McManamy has been appointed by President Wilson to the position of chief inspector of locomotive boilers for the Interstate Commerce Commission to succeed Chief Inspector John F. Ensign, whose death was announced in "Power" of Oct. 14. He entered the service of the Interstate Commerce Commission six years ago as inspector of safety appliances, and while in that position served on the committee which represented the commission in the preparation of the present United States Safety Appliance Standards. When the locomotive inspection law was passed he was promoted by President Taft to the position of assistant chief inspector, which he has held up to the present time, serving as acting chief during the illness of Mr. Ensign. Mr. McManamy has been a member of the Brotherhood of Locomotive Firemen and Engineers for over 20 years.

OBITUARY

A. J. Frith, associate professor of mechanical engineering at Armour Institute, Chicago, Ill., died suddenly, in his office at the institute on Monday morning, Nov. 10, 1913. Professor Frith, who was 61 years of age, was born in Philadelphia, Penn. He graduated from Rensselaer Polytechnic Institute, Troy, N. Y. After graduation he taught thermodynamics in Lehigh University, Bethlehem, Penn. Later, he was connected with a government project in the Mississippi Valley and then with the Diesel Engine Co., in New York. He has been associate professor of mechanical engineering at Armour Institute for the last five years, previous to that having been connected in various capacities with several engineering companies. While at Armour he pursued some important research work. He was a member of the American Society of Mechanical Engineers, the American Society for the Promotion of Engineering Education, and the Association of Automobile Engineers of America.